State of California
The Resources Agency
Department of Water Resources

PROJECT EFFECTS ON GROUNDWATER

STUDY PLAN W5, TASK 2, DRAFT REPORT

Oroville Facilities Relicensing
FERC Project No. 2100

NOVEMBER 2004

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REPORT SUMMARY

This study was undertaken to determine the hyporheic connectivity between the Feather River and ponds within the Oroville Wildlife Area. The “hyporheic zone” comprises the interstices or spaces in the mixture of coarse sand, gravel, and other rocks beneath and beside a river or stream. Downstream from Oroville Dam, the Feather River and the surrounding Oroville Wildlife Area are on young and permeable volcaniclastic and alluvial sediments.

Four ponds were selected from within the Oroville Wildlife Area. Water level loggers were installed in each of these ponds, as well as in the adjacent Feather River channel. Water quality was collected from the river channel and ponds as part of SPW1.

Two of the four sampled ponds within the Oroville Wildlife Area exhibited high connectivity to the Feather River. These two ponds, Upper Pacific Heights Pond and Mile Long Pond, shared physical and chemical water quality characteristics similar to adjacent monitoring stations in the Feather River. Water level data reinforces this conclusion, and on several occasions the river and pond levels exhibited similar fluctuations. The other two ponds studied did not exhibit as high a degree of hydraulic connectivity to the Feather River.

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1.0 INTRODUCTION

Relicensing participants raised concerns about the effects of Project features and operations on groundwater levels and quality downstream from Project facilities. Included in the concerns were Project-related effects to hyporheic zones along the Feather River. The "hyporheic zone" comprises the interstices or spaces in the mixture of coarse sand, gravel, and other rocks beneath and beside a river or stream. The spaces are permeated by flowing water in contact with that in the stream, and are inhabited by a variety of insects and other aquatic organisms, including fish fry.

Existing and future operation of the Oroville Facilities may have effects on the physical, chemical, and biological components of groundwater quality in the Project area. Some physical, chemical, and biological data had previously been collected from groundwater in the Project area. However, these data are not sufficient to determine compliance with Basin Plan criteria, goals, and objectives (CVRWQCB 2003) established for protection of groundwater beneficial uses. Additional physical, chemical, and biological data were needed to demonstrate Project compliance with Basin Plan standards for groundwater.

Oroville Dam and Lake Oroville are underlain by relatively impermeable Mesozoic-era igneous and metamorphic bedrock, which should eliminate any groundwater effects from Lake Oroville. Downstream from the dam, the Feather River and the Thermalito Forebay and Afterbay are on much younger and more permeable volcaniclastic and consolidated alluvial sediments, where groundwater recharge occurs. Due to the porosity of the underlying deposits, the hydraulic heads of the Thermalito Forebay and Afterbay, as well as varied Project-related releases to the Feather River, probably contribute to locally higher groundwater levels

A study plan was developed and approved by the Environmental Workgroup to evaluate the effects from Project facilities and operations on groundwater levels and quality (Task 1) and hyporheic connectivity of the Feather River and Oroville Wildlife Area ponds (Task 2). This report presents results from the hyporheic connectivity (Task 2) investigation.

1.1 BACKGROUND INFORMATION

1.1.1 Statutory/Regulatory Requirements

Demonstration of compliance with basin plan objectives is necessary for the SWRCB to issue a water quality certification. Basin plan objectives for surface waters include provisions that prohibit chemical constituents in concentrations that adversely affect beneficial uses, create tastes and odors, or produce detrimental effects in human, plant, animal, or aquatic life. The water quality certification is needed for license renewal with the Federal Energy Regulatory Commission.

1.1.2 Study Area

The study includes areas within the Oroville Wildlife Area where hyporheic connectivity was anticipated to occur. The study area for Task 2 includes the Feather River in the vicinity of the Oroville Wildlife Area and ponds in the area.

1.2 DESCRIPTION OF FACILITIES

The Oroville Facilities were developed as part of the State Water Project, a water storage and delivery system of reservoirs, aqueducts, power plants, and pumping plants. The main purpose of the SWP is to store and distribute water to supplement the needs of urban and agricultural water users in northern California, the San Francisco Bay area, the San Joaquin Valley, and southern California. The Oroville Facilities are also operated for flood management, power generation, to improve water quality in the Delta, provide recreation, and enhance fish and wildlife.

FERC Project No. 2100 encompasses 41,100 acres and includes Oroville Dam and Reservoir, three power plants (Hyatt Pumping-Generating Plant, Thermalito Diversion Dam Power Plant, and Thermalito Pumping-Generating Plant), Thermalito Diversion Dam, the Feather River Fish Hatchery and Fish Barrier Dam, Thermalito Power Canal, Oroville Wildlife Area, Thermalito Forebay and Forebay Dam, Thermalito Afterbay and Afterbay Dam, and transmission lines, as well as a number of recreational facilities. An overview of these facilities is provided on Figure 1.2-1. The Oroville Dam, along with two small saddle dams, impounds Lake Oroville, a 3.5-million-acre-feet capacity storage reservoir with a surface area of 15,810 acres at its normal maximum operating level.

The hydroelectric facilities have a combined licensed generating capacity of approximately 762 megawatts (MW). The Hyatt Pumping-Generating Plant is the largest of the three power plants with a capacity of 645 MW. Water from the six-unit underground power plant (three conventional generating and three pumping-generating units) is discharged through two tunnels into the Feather River just downstream of Oroville Dam. The plant has a generating and pumping flow capacity of 16,950 and 5,610 cubic feet per second (cfs), respectively. Other generation facilities include the 3-MW Thermalito Diversion Dam Power Plant and the 114-MW Thermalito Pumping-Generating Plant.

Thermalito Diversion Dam, four miles downstream of the Oroville Dam creates a tail water pool for the Hyatt Pumping-Generating Plant and is used to divert water to the

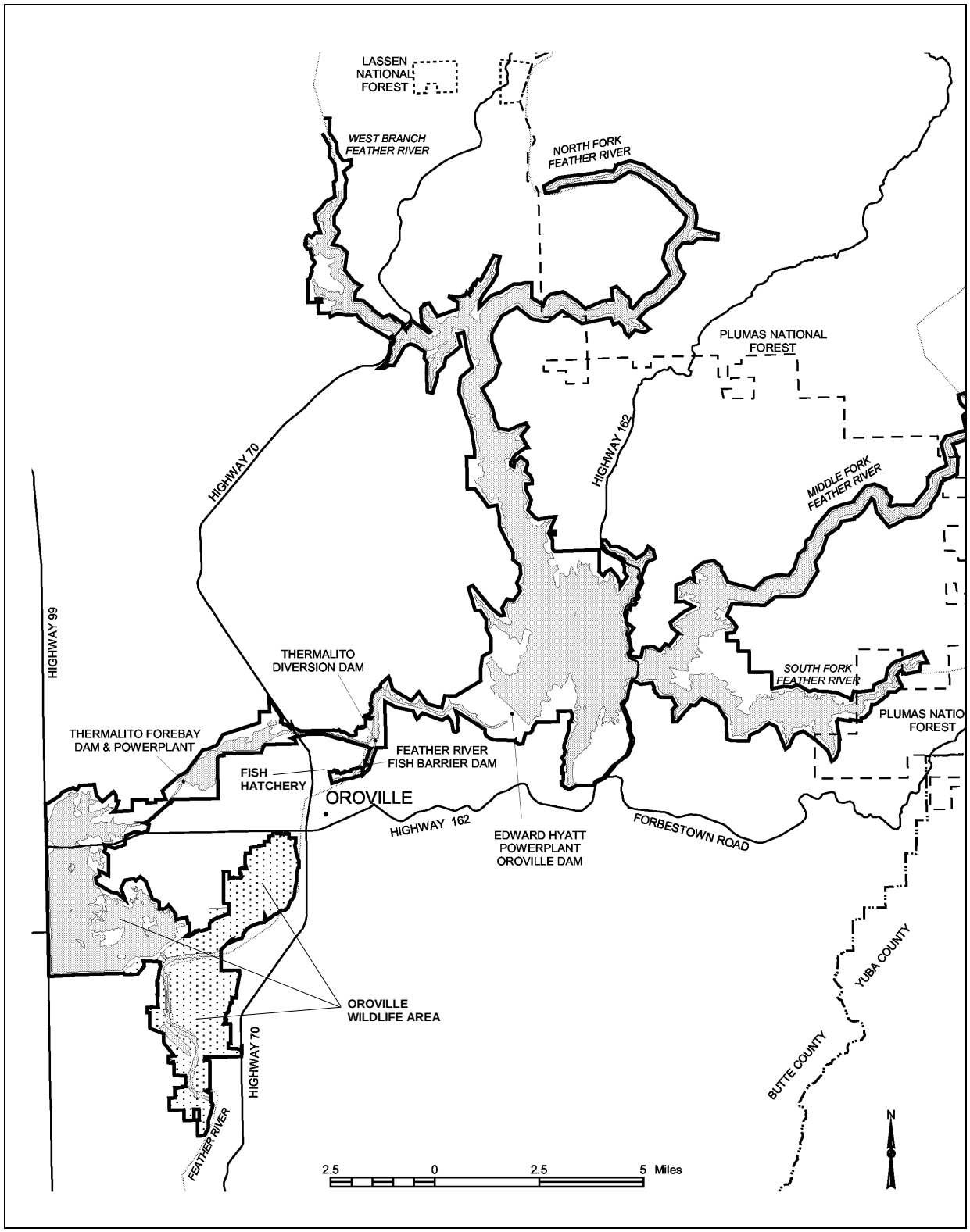


Figure 1.2-1. Oroville Facilities FERC Project Boundary

Thermalito Power Canal. The Thermalito Diversion Dam Power Plant is a 3-MW power plant located on the left abutment of the Diversion Dam. The power plant releases a maximum of 615 cfs of water into the river.

The Power Canal is a 10,000-foot-long channel designed to convey generating flows of 16,900 cfs to the Thermalito Forebay and pump-back flows to the Hyatt Pumping-Generating Plant. The Thermalito Forebay is an off-stream regulating reservoir for the 114-MW Thermalito Pumping-Generating Plant. The Thermalito Pumping-Generating Plant is designed to operate in tandem with the Hyatt Pumping-Generating Plant and has generating and pump-back flow capacities of 17,400 cfs and 9,120 cfs, respectively. When in generating mode, the Thermalito Pumping-Generating Plant discharges into the Thermalito Afterbay, which is contained by a 42,000-foot-long earth-fill dam. The Afterbay is used to release water into the Feather River downstream of the Oroville Facilities, helps regulate the power system, provides storage for pump-back operations, and provides recreational opportunities. Several local irrigation districts receive water from the Afterbay.

The Feather River Fish Barrier Dam is downstream of the Thermalito Diversion Dam and immediately upstream of the Feather River Fish Hatchery. The flow over the dam maintains fish habitat in the low-flow channel of the Feather River between the dam and the Afterbay outlet, and provides attraction flow for the hatchery. The hatchery was intended to compensate for spawning grounds lost to returning salmon and steelhead trout from the construction of Oroville Dam. The hatchery can accommodate 15,000 to 20,000 adult fish annually.

The Oroville Facilities support a wide variety of recreational opportunities. They include: boating (several types), fishing (several types), fully developed and primitive camping (including boat-in and floating sites), picnicking, swimming, horseback riding, hiking, off-road bicycle riding, wildlife watching, hunting, and visitor information sites with cultural and informational displays about the developed facilities and the natural environment. There are major recreation facilities at Loafer Creek, Bidwell Canyon, the Spillway, North and South Thermalito Forebay, and Lime Saddle. Lake Oroville has two full-service marinas, five car-top boat launch ramps, ten floating campsites, and seven dispersed floating toilets. There are also recreation facilities at the Visitor Center and the Oroville Wildlife Area.

The Oroville Wildlife Area comprises approximately 11,000 acres west of Oroville that is managed for wildlife habitat and recreational activities. It includes the Thermalito Afterbay and surrounding lands (approximately 6,000 acres) along with 5,000 acres adjoining the Feather River. The 5,000 acre area straddles 12 miles of the Feather River, which includes willow and cottonwood lined ponds, islands, and channels. Recreation areas include dispersed recreation (hunting, fishing, and bird watching), plus recreation at developed sites, including Monument Hill day use area, model airplane grounds, three boat launches on the Afterbay and two on the river, and two primitive

camping areas. California Department of Fish and Game's habitat enhancement program includes a wood duck nest-box program and dry land farming for nesting cover and improved wildlife forage. Limited gravel extraction also occurs in a number of locations.

1.3 CURRENT OPERATIONAL CONSTRAINTS

Operation of the Oroville Facilities varies seasonally, weekly and hourly, depending on hydrology and the objectives DWR is trying to meet. Typically, releases to the Feather River are managed to conserve water while meeting a variety of water delivery requirements, including flow, temperature, fisheries, recreation, diversion and water quality. Lake Oroville stores winter and spring runoff for release to the Feather River as necessary for Project purposes. Meeting the water supply objectives of the SWP has always been the primary consideration for determining Oroville Facilities operation (within the regulatory constraints specified for flood control, in-stream fisheries, and downstream uses). Power production is scheduled within the boundaries specified by the water operations criteria noted above. Annual operations planning is conducted for multi-year carry over. The current methodology is to retain half of the Lake Oroville storage above a specific level for subsequent years. Currently, that level has been established at 1,000,000 acre-feet (af); however, this does not limit draw down of the reservoir below that level. If hydrology is drier than expected or requirements greater than expected, additional water would be released from Lake Oroville. The operations plan is updated regularly to reflect changes in hydrology and downstream operations. Typically, Lake Oroville is filled to its maximum annual level of up to 900 feet above mean sea level in June and then can be lowered as necessary to meet downstream requirements, to its minimum level in December or January. During drier years, the lake may be drawn down more and may not fill to the desired levels the following spring. Project operations are directly constrained by downstream operational constraints and flood management criteria as described below.

1.3.1 Downstream Operation

An August 1983 agreement between DWR and DFG entitled, "Agreement Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish & Wildlife," sets criteria and objectives for flow and temperatures in the low flow channel and the reach of the Feather River between Thermalito Afterbay and Verona. This agreement: (1) establishes minimum flows between Thermalito Afterbay Outlet and Verona which vary by water year type; (2) requires flow changes under 2,500 cfs to be reduced by no more than 200 cfs during any 24-hour period, except for flood management, failures, etc.; (3) requires flow stability during the peak of the fall-run Chinook spawning season; and (4) sets an objective of suitable temperature conditions during the fall months for salmon and during the later spring/summer for shad and striped bass.

1.3.1.1 Instream Flow Requirements

The Oroville Facilities are operated to meet minimum flows in the Lower Feather River as established by the 1983 agreement (see above). The agreement specifies that Oroville Facilities release a minimum of 600 cfs into the Feather River from the Thermalito Diversion Dam for fisheries purposes. This is the total volume of flows from the diversion dam outlet, diversion dam power plant, and the Feather River Fish Hatchery pipeline.

Generally, the instream flow requirements below Thermalito Afterbay are 1,700 cfs from October through March, and 1,000 cfs from April through September. However, if runoff for the previous April through July period is less than 1,942,000 af (i.e., the 1911-1960 mean unimpaired runoff near Oroville), the minimum flow can be reduced to 1,200 cfs from October to February, and 1,000 cfs for March. A maximum flow of 2,500 cfs is maintained from October 15 through November 30 to prevent spawning in overbank areas that might become de-watered.

1.3.1.2 Temperature Requirements

The Diversion Pool provides the water supply for the Feather River Fish Hatchery. The hatchery objectives are 52 ºF for September, 51 ºF for October and November, 55 ºF for December through March, 51 ºF for April through May 15, 55 ºF for last half of May, 56 ºF for June 1-15, 60 ºF for June 16 through August 15, and 58 ºF for August 16-31. A temperature range of plus or minus 4 ºF is allowed for objectives, April through November.

There are several temperature objectives for the Feather River downstream of the Afterbay Outlet. During the fall months, after September 15, the temperatures must be suitable for fall-run Chinook. From May through August, they must be suitable for shad, striped bass, and other warmwater fish.

The National Oceanic and Atmospheric Administration – Fisheries (formerly National Marine Fisheries Service) has also established an explicit criterion for steelhead trout and spring-run Chinook salmon. Memorialized in a biological opinion on the effects of the Central Valley Project and SWP on Central Valley spring-run Chinook and steelhead as a reasonable and prudent measure; DWR is required to control water temperature at Feather River mile 61.6 (Robinson's Riffle in the low-flow channel) from June 1 through September 30. This measure requires water temperatures less than or equal to 65 ºF on a daily average. The requirement is not intended to preclude pump-back operations at the Oroville Facilities needed to assist the State of California with supplying energy during periods when the California ISO anticipates a Stage 2 or higher alert.

The hatchery and river water temperature objectives sometimes conflict with temperatures desired by agricultural diverters. Under existing agreements, DWR

provides water for the Feather River Service Area (FRSA) contractors. The contractors claim a need for warmer water during spring and summer for rice germination and growth (i.e., 65 ºF from approximately April through mid May, and 59 ºF during the remainder of the growing season). There is no obligation for DWR to meet the rice water temperature goals. However, to the extent practical, DWR does use its operational flexibility to accommodate the FRSA contractor's temperature goals.

1.3.1.3 Water Diversions

Monthly irrigation diversions of up to 190,000 (July 2002) af are made from the Thermalito Complex during the May through August irrigation season. Total annual entitlement of the Butte and Sutter County agricultural users is approximately 1 maf. After meeting these local demands, flows into the lower Feather River continue into the Sacramento River and into the Sacramento-San Joaquin Delta. In the northwestern portion of the Delta, water is pumped into the North Bay Aqueduct. In the south Delta, water is diverted into Clifton Court Forebay where the water is stored until it is pumped into the California Aqueduct.

1.3.1.4 Water Quality

Flows through the Delta are maintained to meet Bay-Delta water quality standards arising from DWR's water rights permits. These standards are designed to meet several water quality objectives such as salinity, Delta outflow, river flows, and export limits. The purpose of these objectives is to attain the highest water quality, which is reasonable, considering all demands being made on the Bay-Delta waters. In particular, they protect a wide range of fish and wildlife including Chinook salmon, Delta smelt, striped bass, and the habitat of estuarine-dependent species.

1.3.2 Flood Management

The Oroville Facilities are an integral component of the flood management system for the Sacramento Valley. During the wintertime, the Oroville Facilities are operated under flood control requirements specified by the U.S. Army Corps of Engineers (USACE). Under these requirements, Lake Oroville is operated to maintain up to 750,000 af of storage space to allow for the capture of significant inflows. Flood control releases are based on the release schedule in the flood control diagram or the emergency spillway release diagram prepared by the USACE, whichever requires the greater release. Decisions regarding such releases are made in consultation with the USACE.

The flood control requirements are designed for multiple use of reservoir space. During times when flood management space is not required to accomplish flood management objectives, the reservoir space can be used for storing water. From October through March, the maximum allowable Oroville Wildlife Area storage limit (point at which specific flood release would have to be made) varies from about 2.8 to 3.2 maf to

ensure adequate space in Lake Oroville to handle flood flows. The actual encroachment demarcation is based on a wetness index, computed from accumulated basin precipitation. This allows higher levels in the reservoir when the prevailing hydrology is dry while maintaining adequate flood protection. When the wetness index is high in the basin (i.e., wetness in the watershed above Lake Oroville), the flood management space required is at its greatest amount to provide the necessary flood protection. From April through June, the maximum allowable Oroville Wildlife Area storage limit is increased as the flooding potential decreases, which allows capture of the higher spring flows for use later in the year. During September, the maximum allowable Oroville Wildlife Area storage decreases again to prepare for the next flood season. During flood events, actual storage may encroach into the flood reservation zone to prevent or minimize downstream flooding along the Feather River.

2.0 NEED FOR STUDY

Construction of Oroville Dam, impoundment of water to form Lake Oroville, and associated facilities of the Project have affected the physical, chemical, and biological characteristics of water in the Feather River. Since the Feather River provides recharge to local groundwater, these changes in water quality characteristics in the river may subsequently affect groundwater characteristics. Ponds in the Oroville Wildlife Area are likely hydraulically connected to the Feather River, and thus may also be affected by the water quality characteristics of the Feather River.

Though the Project may potentially affect biological characteristics of groundwater, aquatic macroinvertebrates as a component of the biological characteristics of groundwater are not included for study since sufficient information about these organisms is being obtained from riffle areas of the Feather River in Study Plans SPW1 and SPF1.

Prior to issuance of a new license for the Project, the Federal Energy Regulatory Commission (FERC) will require a water quality certification by the State Water Resources Control Board (SWRCB). The certification requires a determination by the SWRCB that the Project complies with appropriate requirements of the Central Valley Regional Water Quality Control Board (CVRWQCB) Basin Plan, which includes water quality objectives for protection of designated beneficial uses.

Information obtained from the study will be used to determine Project effects to pond water levels and quality within the Oroville Wildlife Area, demonstrate compliance with water quality standards and other appropriate requirements in the application for water quality certification, and identify the need for Project modification or mitigation for impacts to water quality from Project operations. Water quality analysis is required for determination of conditions in the water quality certification by the SWRCB.

3.0 STUDY OBJECTIVE

The objective of this study is to demonstrate the degree of hyporheic connectivity between the Feather River and selected ponds within the Oroville Wildlife Area.

3.1 APPLICATION OF STUDY INFORMATION

Information from the study will be used to determine compliance with basin plan objectives, which is necessary for the SWRCB to issue a water quality certification. The water quality certification is needed for license renewal with FERC. Data from this study will also be used by various agencies, such as the DFG and U.S. Fish and Wildlife Service, to evaluate any Project related effects to wildlife species that may prey on aquatic species in waters affected by Project releases.

4.0 METHODOLOGY

This study evaluates effects from Project features to hyporheic interaction of the Feather River with ponds in the Oroville Wildlife Area.

4.1 STUDY DESIGN

The study included the evaluation of effects of any hydraulic connectivity between the Feather River and Oroville Wildlife Area ponds. Included in this analysis is a comparison of Feather River water quality data to that found in the Oroville Wildlife Area ponds.

4.1.1 Sampling Sites

Four ponds within the Oroville Wildlife Area at various distances from the east and west sides of the Feather River were selected for water level and water quality monitoring (Figure 4.1.1-1).

The first of the selected ponds is part of the Oroville Fishing Area. There are two man-made ponds at this location, but only the southern pond was analyzed. This pond is a large oval shaped pond lying approximately 100 feet from the Feather River channel. The next pond selected lies to the northwest of Robinson Riffle. This pond, Robinson Riffle Pond, is a narrow, shallow pond. The third pond selected is Upper Pacific Heights Pond which is a large, deep pond to the south of Eye Riffle on the Feather River. All three of these ponds are adjacent to the low flow channel of the Feather River.

The final pond selected for study is Mile Long Pond (which is also known as One Mile Pond). This is the only pond selected adjacent to the high flow channel downstream from the Afterbay Outlet.

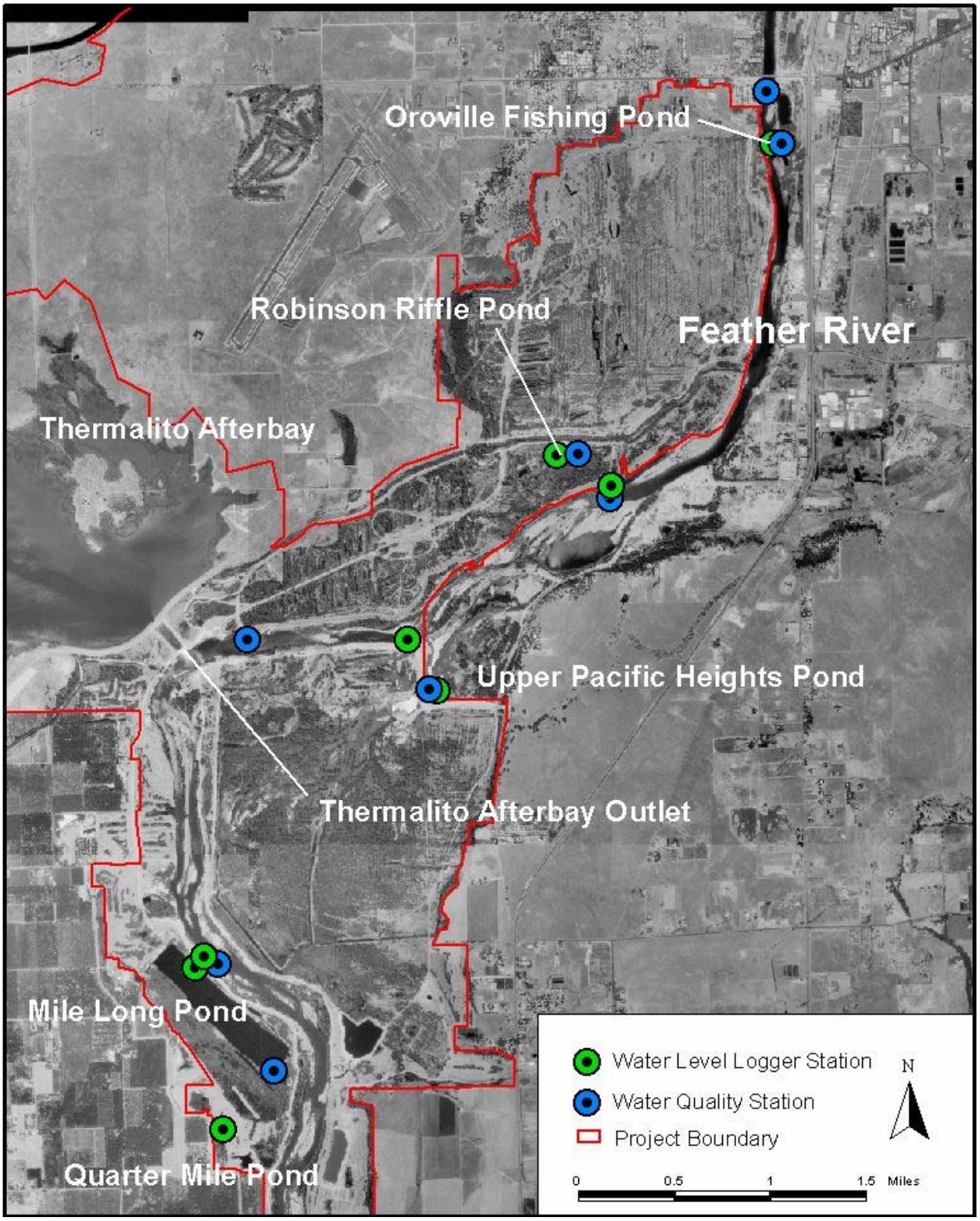
A fifth pond was added southwest of Mile Long Pond in December of 2003. Pond water level loggers were installed in this pond, named Quarter Mile Pond.

River water quality data was obtained from SPW1 monitoring stations adjacent to the selected ponds.

4.1.2 Sampling Method

Water level measurements were taken using both Global Water and Solinst water level loggers. The Global Water WL15X Water Level Logger and Solinst Model 3001 Levelogger consist of a datalogger with a submersible pressure transducer for remote monitoring and recording of water pressure data. Upon installation of the loggers, a

Figure 4.1.1-1. Task 2 Hyporheic monitoring stations



survey to establish the elevation relationship between the pond and river stations was performed. Rebar monuments were set in the ground, with GPS coordinates recorded. An assumed elevation of 100 feet above sea level was used to detail the elevation difference.

In order to calibrate water level readings and adjust for instrument drift, staff gages were installed at each pond and river station in February 2003. Additional staff gages were installed in various ponds throughout the Oroville Wildlife Area in April 2004. These readings were recorded monthly.

Water samples were collected monthly as part of SPW1. Samples were collected from stations within the Feather River and in the ponds. Stream samples or measurements were collected about one foot below the surface in flowing, well-mixed riffle or run areas. Dissolved oxygen was measured in streams by titration (azide modification of the iodometric method). Basic water quality parameters were measured in the ponds from the surface to the bottom at one meter intervals. Temperature and dissolved oxygen in the ponds were measured at one meter intervals using meters and membrane electrode probes calibrated at the surface using the iodometric method. Conductivity and pH were measured with meters and probes in samples collected at one meter intervals with a van Dorn water bottle. Turbidity was measured with a nephelometer from samples collected using the van Dorn water bottle.

Field sampling procedures followed DWR's *Sampling Manual for Environmental Measurement Projects* (DWR 1994). Water temperature, dissolved oxygen, conductivity, and pH were measured in the field at each monitoring station. Conductivity and water temperature were measured with an Orion Model 128 conductivity/temperature meter. A Hellige comparator was used for pH determination.

Water samples were collected in sample-rinsed polyethylene bottles for physical analyses. Samples were transported to the DWR Northern District laboratory for physical analyses.

Samples for nutrient and mineral analyses were collected in sample-rinsed polyethylene bottles. Samples for dissolved parameters were filtered through a 0.45 micron pore diameter nitrocellulose membrane filter. The samples were then preserved per standard procedures and submitted to DWR's Bryte Chemical Laboratory in West Sacramento, California. Samples were analyzed according to protocols approved by the U.S. Environmental Protection Agency or American Public Health Association (APHA 1998).

Samples for trace metals analyses were collected in accordance with methods outlined in USEPA Method 1669 (USEPA 1996). Samples were collected for total recoverable and dissolved fractions of aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, selenium, and silver. Total recoverable mercury and methyl

mercury were also collected. The bottles for total recoverable and dissolved metals were provided by DWR's Bryte Chemical Laboratory, which performed the analyses. The bottles for mercury analyses were provided by Frontier Geosciences in Seattle, Washington, which performed the mercury analyses.

5.0 STUDY RESULTS

5.1 TASK 2, HYPORHEIC MONITORING

5.1.1 Hyporheic Monitoring

Plotting daily average water levels for each of the ponds and their adjacent river stations revealed a strong hydraulic connection between the Feather River and two of the selected ponds. Upper Pacific Heights Pond and Mile Long Pond show a direct hydraulic connection to the flows in the Feather River (Appendix 1a through e). The other two ponds analyzed in the Oroville Wildlife Area (Oroville Fishing Pond and Robinson Riffle Pond) do not appear to have a strong hydraulic relationship with the Feather River.

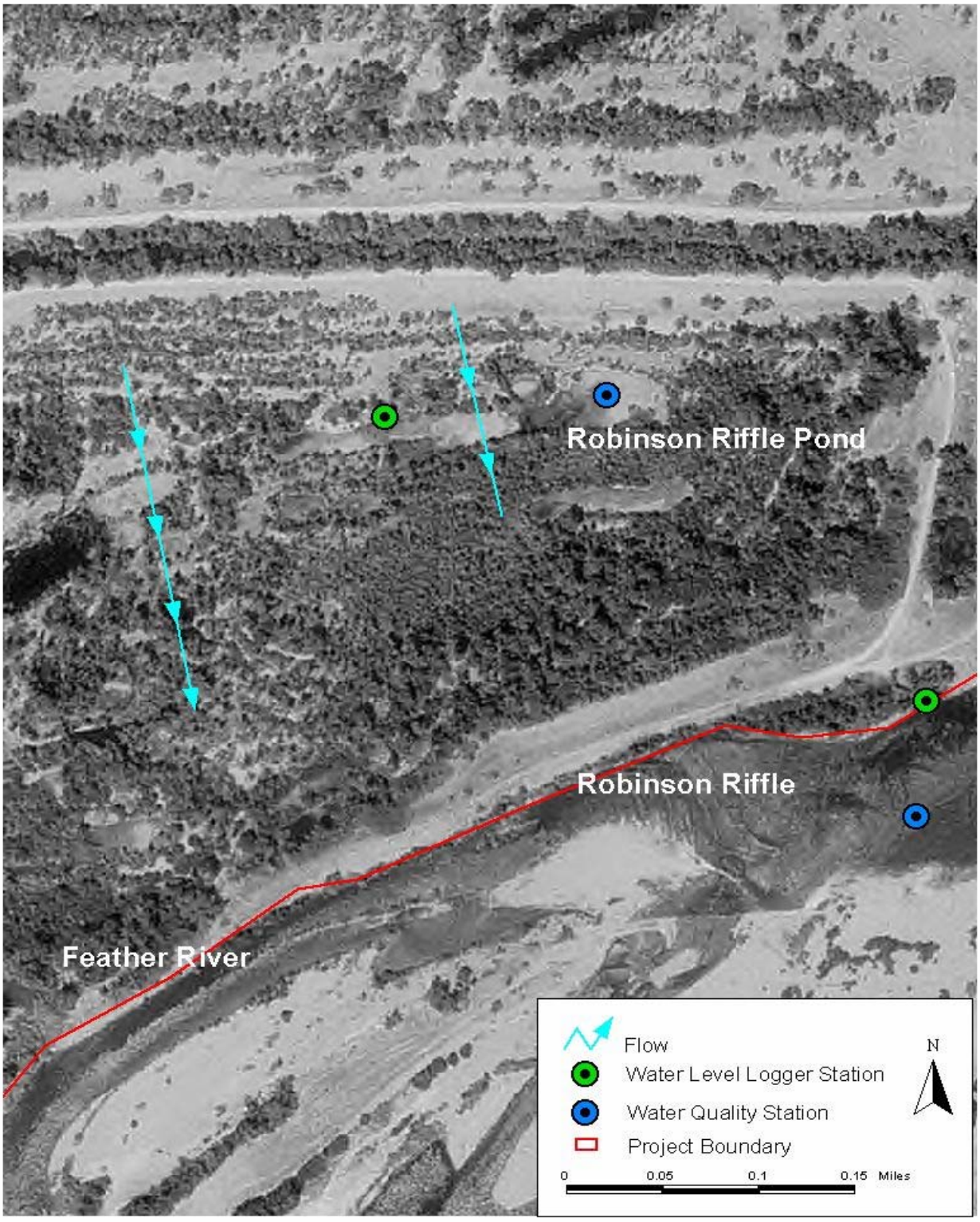
Water level data from the Oroville Fishing Pond and the Feather River near the Oroville Fishing Pond show that although the levee separating these two water bodies is only about 100 feet wide, little correlation between them exists. The pond fills in the winter due to rainfall (Appendix 1a) and drops just below the surface elevation of the Feather River in the summer. The difficulty with the analysis of the data from this station is that the Oroville Recreation and Parks District (ORPD) utilizes a small well near the upper Oroville Fishing Pond. Water from this well is used to clean restrooms and periodically fill the ponds. The ORPD does not keep a record or log of well usage, but estimate that the pump is turned on for a half-hour daily and sporadically when needed to fill this pond (Bob Sharkey, ORPD per. comm.). The north and south pond are connected by a small ditch (Figure 5.1.1-1).

Robinson Riffle Pond is a small, narrow pond lying to the northwest of Robinson Riffle. Water level data from this pond indicate that the water levels are influenced by rainfall and runoff and are not associated with the Feather River. The data show that during the winter months and significant rainfall events, this pond fills quickly with runoff, even if the Feather River maintains a fairly constant water surface elevation. This has been documented on several occasions by field staff having to wade through water to reach the pond's edge. Water has been observed flowing out of the levee to the north of this pond, flowing south into the pond, and then south out of the pond (Figure 5.1.1-2).

In July and August, the water surface elevation in Robinson Riffle Pond begins dropping rapidly, eventually falling well below the water surface elevation of the adjacent Feather River (Appendix 1b).

Figure 5.1.1-1. Oroville Fishing Pond features.

Figure 5.1.1-2. Robinson Riffle Pond flow dynamics.



Upper Pacific Heights Pond is a long, deep pond lying on the southeast side of the Feather River near Eye Riffle. This pond shares a connection with the Feather River through the east levee. Water has been observed flowing through the porous levee and into Upper Pacific Heights Pond (Figure 5.1.1-3). Beaver dams within this pond have raised the water surface elevation three feet above that of the river channel. This was not known at the time of site selection. Water level data from this area show that the relationship between this pond and the Feather River is strong. Afterbay outlet releases have the effect of backing up water coming down the low flow channel upstream as far as Eye Riffle. Plotting pond and river levels against Afterbay releases, the hydraulic connection between the two is evident (Appendix 1c). Rainfall also contributes to levels in this pond. The combination of rainfall and the Afterbay releases causes water levels in the pond to rise.

Mile Long Pond is a large, well known pond in the south-west portion of the Oroville Wildlife Area. This pond is downstream from the Afterbay outlet, and releases from the outlet have a direct effect on water levels in this pond. Water level data from the pond show a direct hydraulic correlation with river levels. When Afterbay releases are ramped up, water flows through the levee separating the pond and river and into the pond. Mile Long Pond then fills to its banks and water spreads out over the adjacent floodplain to the west and south (Figure 5.1.1-4).

Quarter Mile Pond was first examined in December 2003 when a Solinst water level recorder was installed. This pond is found to the south-west of Mile Long Pond, and is in the floodplain of Mile Long Pond. Water appears to spread out from Mile Long Pond in a southwesterly direction, filling the small ponds, such as Quarter Mile Pond, found in the area.

Staff gage levels were recorded during each visit to the monitoring sites. These gages show similar relationships as the water level loggers (Appendix 2a-d). Additional staff gages installed in April 2004 have not been in place long enough to develop the understanding of hydraulic connection between the Feather River and these ponds. Due to this, vandalism, and the rapid water level changes, these data are not graphed, but are presented as a table in Appendix 2e.

Figure 5.1.1-3. Upper Pacific Heights Pond features.

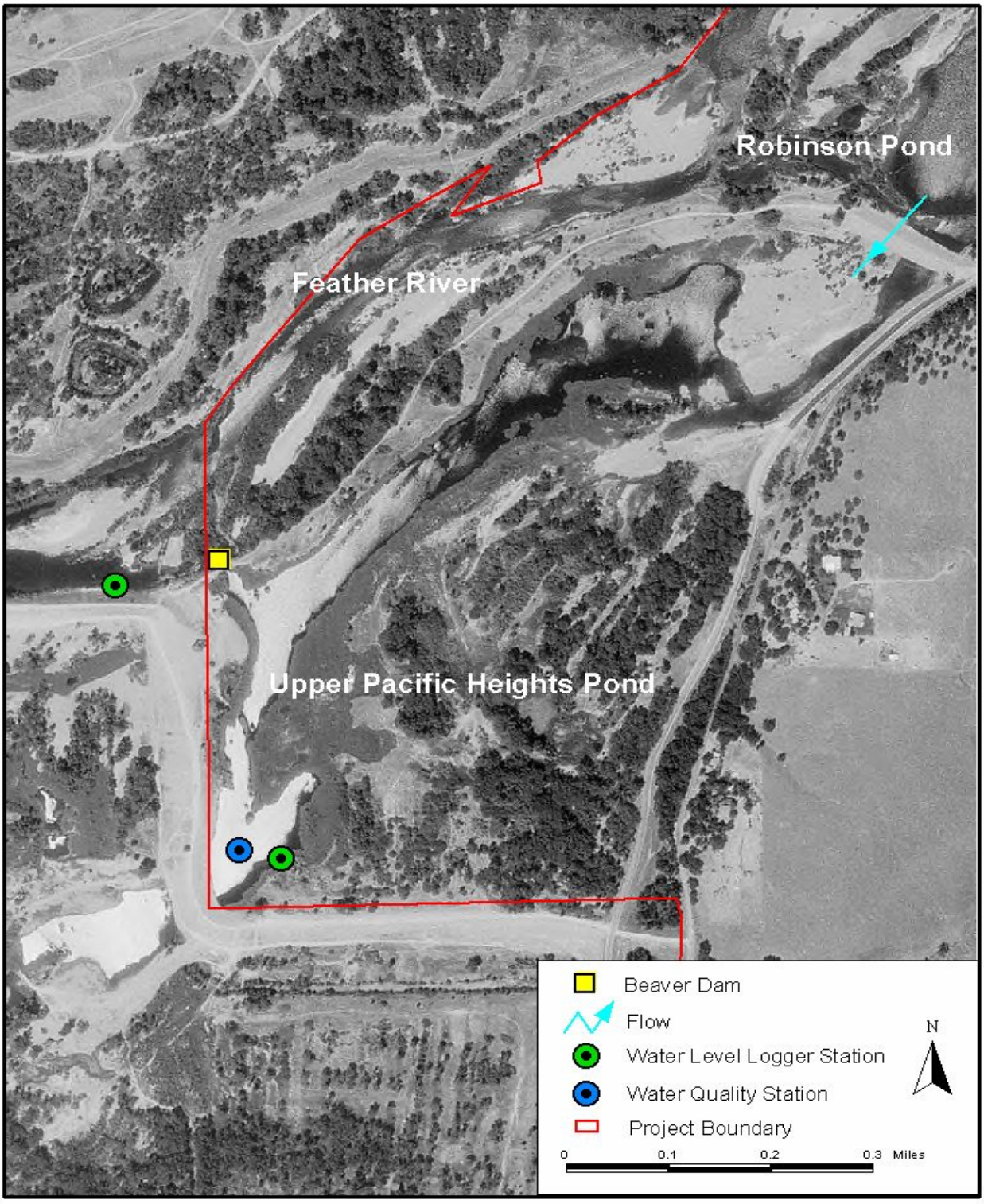
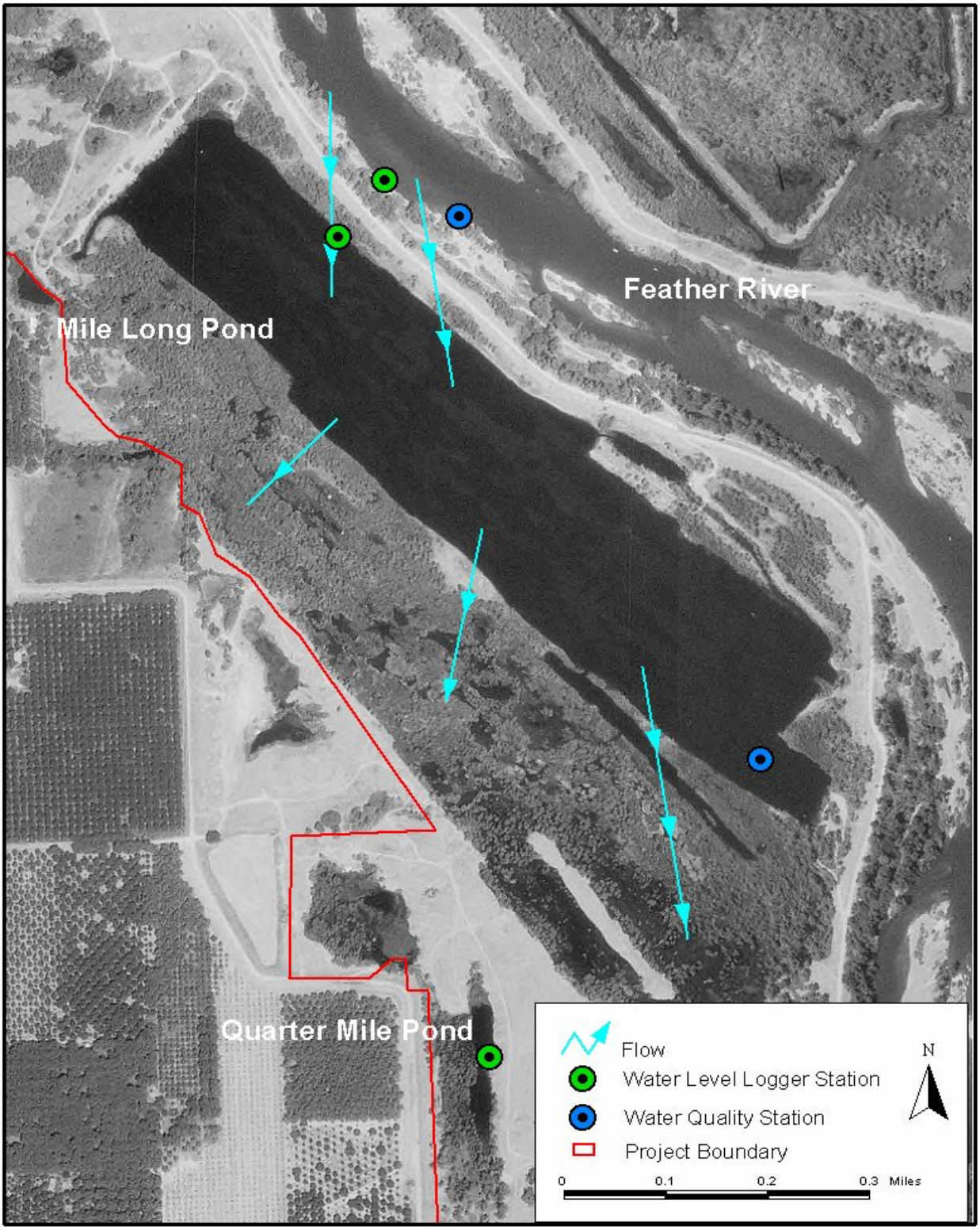


Figure 5.1.1-4 Mile Long Pond flow dynamics.



5.1.2 Water Quality

5.1.2.1 Physical parameters

Physical parameters analyzed as part of SPW1 include dissolved oxygen, pH, conductivity, alkalinity, and turbidity (Appendix 4). Water temperatures were analyzed as part of SPW6 (Appendix 3).

There are currently no recommendations or criteria for areas such as the Oroville Wildlife Area ponds. The Basin plan states that *in well mixed* waters of the Feather River system, dissolved oxygen shall not fall below 5.0 mg/L for warm water habitat and 7.0 mg/L for cold water habitat. In addition, dissolved oxygen in Feather River from the Fish Barrier Dam at Oroville to Honcut Creek shall not fall below 8.0 mg/L from September 1 through May 31. All ponds sampled exhibited dissolved oxygen results that fell below 5.0 mg/L, except Mile Long Pond. The low dissolved oxygen results in the ponds are not due to any known Project influence from the Feather River as all results obtained from the river channel were above the 7.0 mg/L limit, with only one measurement below the 8.0 mg/L criterion.

All pH results from the ponds and the adjacent Feather River monitoring stations were within established criteria.

Conductivity results found in the Upper Pacific Heights and Mile Long ponds were similar to those found in the adjacent river channel (Figure 5.1.2.1-1). However, monitoring stations in the Oroville Fishing and Robinson Riffle ponds exhibited much higher conductivity than the adjacent river channel (Figure 5.1.2.1-2). Results obtained at these two stations ranged from 395 to 91 micromhos/cm. Samples collected in the Feather River channel adjacent to these ponds ranged from 114 to 79 micromhos/cm. These data suggest that the connectivity of these ponds to the Feather River is limited. The high conductivity results in the two ponds appear to be a result of upland runoff and flow from sources outside of Project influences.

Alkalinity results correlated with the results of conductivity sampling. Upper Pacific Heights and Mile Long ponds had alkalinities similar to the river, while Oroville Fishing and Robinson Riffle ponds exhibited much higher levels due to upland flow and runoff.

Turbidity results did not identify any connection between the ponds and the Feather River. This is to be expected as turbidity in the ponds was dependant on various factors such as runoff and wind. Highest turbidity levels for all stations occurred during winter months and was closely associated with storms.

Water temperature results from SPW6 show that the ponds exhibit much higher temperatures than the river channel throughout most of the year. During the winter months of December, January, and February, temperatures within the ponds approach

those found in the river. The Feather River temperatures are regulated by the requirement at Robinson Riffle and are not to exceed 65 ºF during certain times of the year. The warm temperatures within the ponds are a result of increased retention time upon which air temperature and sunlight can affect the water temperatures. All water temperatures found in the ponds are influenced and correlate with changes in air temperature (Appendix 3).

5.1.2.2 Mineral parameters

Minerals analyzed include calcium, magnesium, sodium, potassium, sulfate, chloride, boron, and hardness. Mineral data from monitoring stations reinforce the conclusion of strong hydraulic connectivity of the Feather River to Upper Pacific Heights and Mile Long ponds. Similar concentrations of all minerals and hardness were found for these two ponds and the Feather River (Appendix 5).

Mineral results for the Oroville Fishing and Robinson Riffle ponds indicate no connection to the Feather River. Concentrations of calcium and magnesium are much higher in these two ponds than the monitoring stations in the adjacent river channel. The high concentrations of these two elements in the Oroville Fishing Pond is likely due to the daily use of the small well at the north pond of the Oroville Fishing area, as described earlier. Groundwater results obtained in the Oroville area from Task 1 of SPW5 show similar concentrations of these two elements (DWR 2004. SPW5). In Robinson Riffle Pond, connection to upland flow is likely causing these concentrations.

Figure 5.1.2.1-1 Conductivity in the Oroville Fishing and Robinson Riffle ponds.

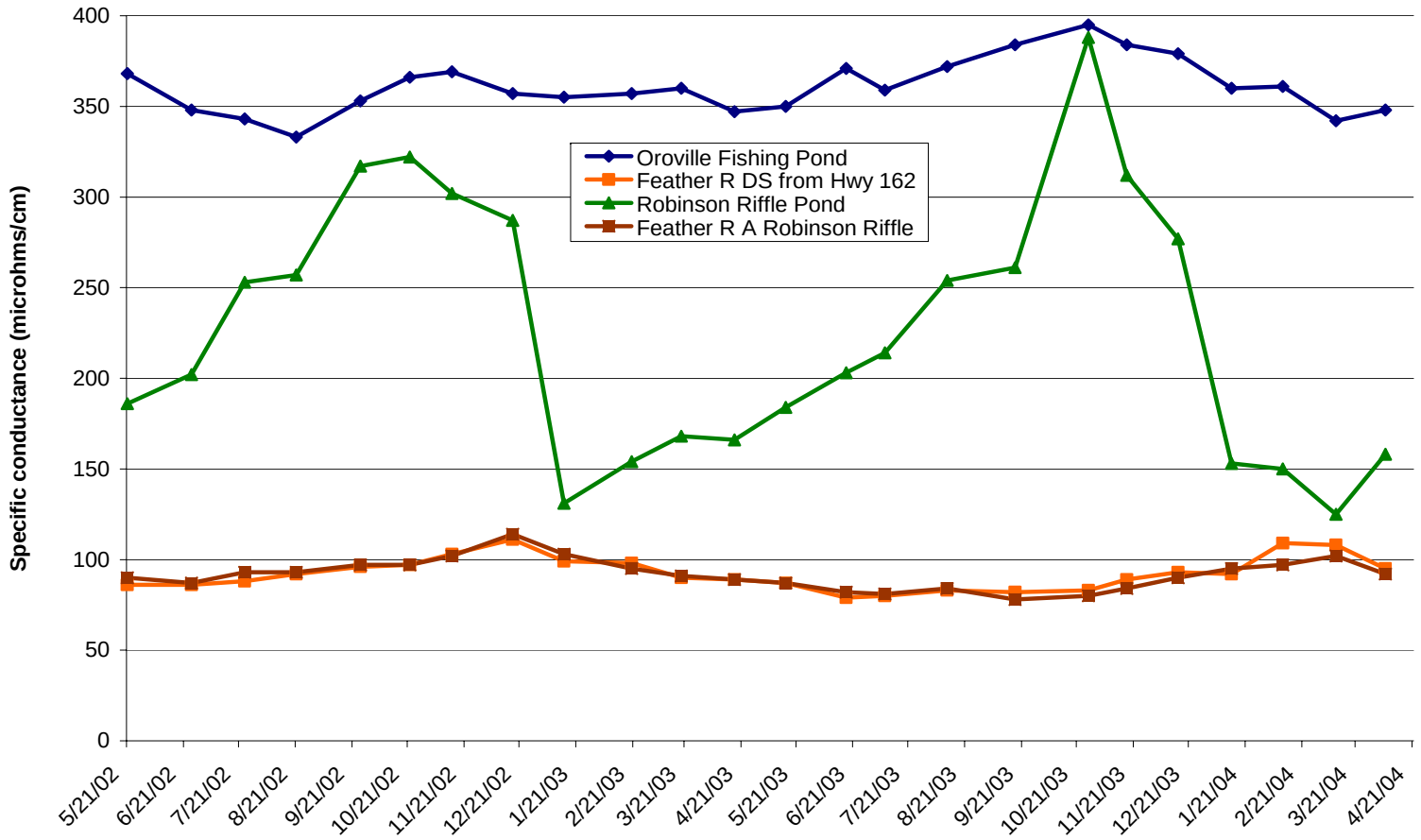
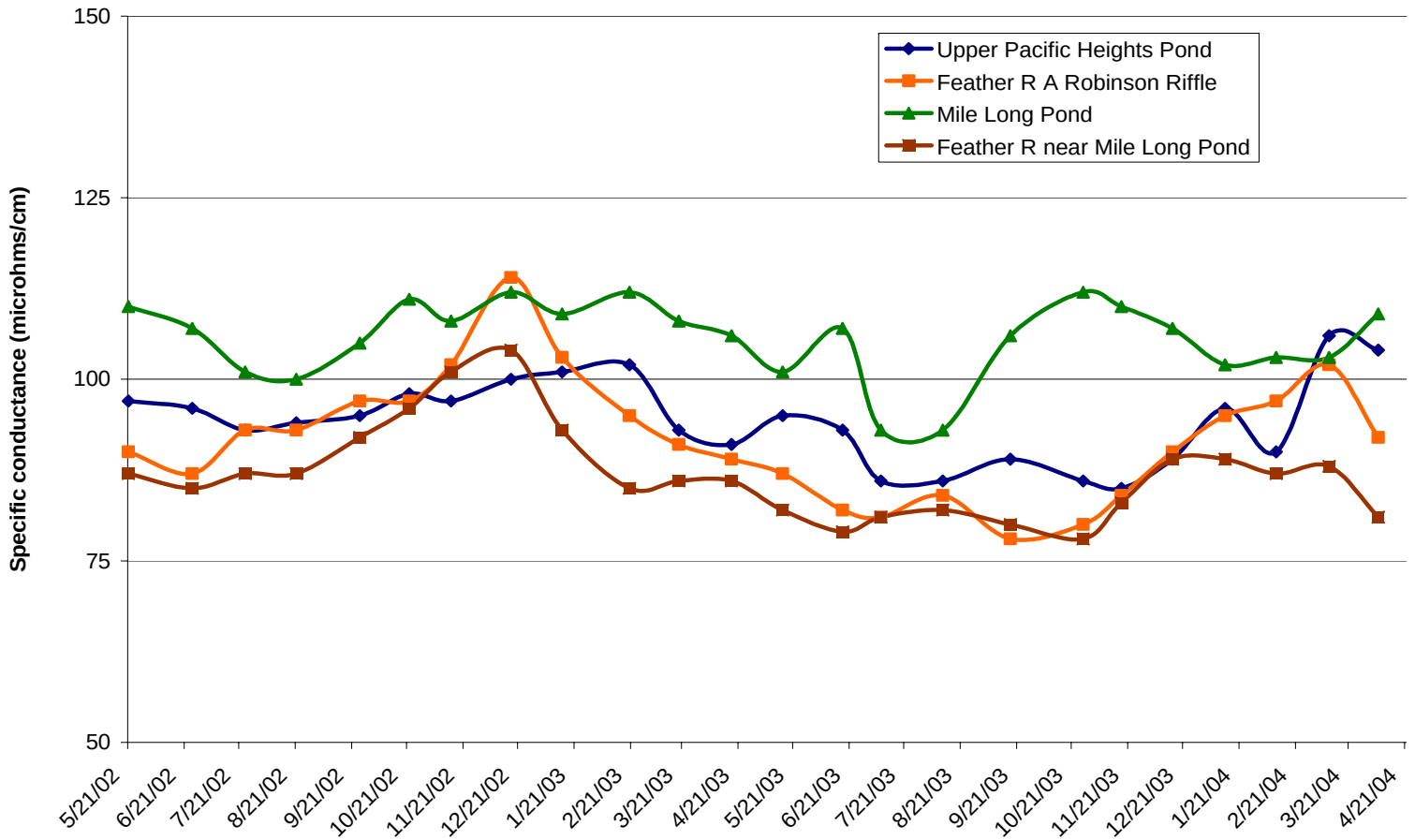


Figure 5.1.2.1-2 Conductivity in the Upper Pacific Heights and Mile Long ponds.



5.1.2.3 Metal parameters

Metals results were graphed and analyzed as part of SPW1 (Appendix 6). Metal levels in Oroville Wildlife Area ponds were similar to those in the Feather River. One exception to this was manganese in Oroville Fishing, Robinson Riffle, and Mile Long ponds. Manganese levels in these three ponds were not found at any station sampled in the Feather River.

Analytical results for metals from the ponds were often at much higher concentrations than those found in the adjacent river channel. The combination of runoff and the physical processes within the ponds may be creating an environment where dissolution from particulate matter and sediments occurs, releasing these elements into the water column.

5.1.2.4 Nutrient parameters

Nutrients results were graphed and analyzed as part of SPW1 (Appendix 7). Results for total phosphorus from the Feather River occasionally exceeded the USEPA Ambient Water Quality Criteria Recommendations for rivers and streams in Ecoregion 1 (USEPA 2001). These exceedances are associated with storm events. Nutrient levels were generally higher in the ponds than in the river, however there are no established nutrient criteria.

6.0 ANALYSES

The purpose of Task 2 of this study was to determine any hydraulic connectivity between the Feather River and ponds of the Oroville Wildlife Area.

6.1 EXISTING CONDITIONS/ENVIRONMENTAL SETTING

6.1.1 Hyporheic Connectivity

The data indicate that there is hydraulic connection between the Feather River and some ponds within the Oroville Wildlife Area. This connection is dependent upon many variables such as elevation, proximity to the river channel, and structural makeup of the channel and ponds. Of the four ponds sampled, two have exhibited a strong hydraulic connection with the Feather River. Both of these ponds lie adjacent to the Feather River and are heavily influenced by stage fluctuations in the river channel. These two ponds are also within the area of influence of the Afterbay outlet.

The other two ponds sampled (Oroville Fishing and Robinson Riffle ponds) did not exhibit as high a degree of connectivity. Oroville Fishing Pond lies directly adjacent to the Feather River, but groundwater and surface runoff have greater effects upon the pond characteristics. Robinson Riffle Pond does not appear to share hydraulic connection with the Feather River. Data collected from this pond suggests sources outside of the Project influence, such as runoff, contribute to this pond's distinct makeup.

6.1.2 Water Quality

Water quality in the Feather River downstream from Oroville Dam is affected by that in releases from the reservoir. Though low dissolved oxygen conditions are occasionally encountered in the reservoir, the dissolved oxygen in the Diversion Pool is at levels suitable for beneficial uses. Downstream in the Feather River, dissolved oxygen levels infrequently were found at levels less than those suitable for certain beneficial uses. Nutrients and minerals downstream from Oroville Dam are at levels suitable for all beneficial uses. Metals in the Diversion Pool at the base of the dam reflect the quality of water in the reservoir near the dam. Further downstream, accretions to the river from tributaries, storm drains, surface runoff, and other sources affect metals in the river. Metals occasionally exceeding various criteria within the Project boundary in the Feather River downstream from the Fish Barrier Dam include aluminum, arsenic, cadmium, copper, iron, and mercury.

Some ponds in the Oroville Wildlife Area also occasionally were found with depressed oxygen levels. While nutrients and minerals in the ponds were at acceptable levels, several metals occasionally were found at elevated levels. Aluminum, arsenic, and iron levels in the ponds were similar to concentrations found in the Feather River near the

ponds. Occasionally manganese was also found at elevated levels in some ponds, though not present at elevated levels in the river.

6.2 PROJECT RELATED EFFECTS

6.2.1 Project Effects on Hyporheic zone

Project effects on the hyporheic zone are difficult to characterize. Controlled flows within the low flow channel and ramping of Afterbay outlet releases influence pond levels. This study shows that there is an effect upon movement of water through the hyporheic zone due to water released from the Afterbay outlet. Water backs up upstream from the outlet, which causes water levels in ponds in the area to increase. The high releases also recharge ponds downstream from the Afterbay outlet. Results of this study do not reveal any negative impacts due to Project influences upon the hyporheic zone.

6.2.2 Project Effects on Pond Water Quality Physical Parameters

There is no indication that Project waters are impacting water quality of the ponds within the Oroville Wildlife Area. The water quality of the water flowing through the low flow channel is generally good, and no significant impacts to the ponds from this water were found.

6.2.3 Project Effects on Pond Water Mineral Parameters

With mineral concentrations in Project waters lower than those found in the Oroville Wildlife Area ponds, especially Oroville Fishing and Robinson Riffle ponds, there does not appear to be any negative impact upon the pond mineral concentrations due to Project influences.

6.2.4 Project Effects on Pond Water Metal Parameters

There is no indication of Project impacts from metals upon the Oroville Wildlife Area ponds. All of the ponds shared similar concentrations of most metals with the Project waters. Iron and manganese were found in much higher concentrations within the ponds, but this is due to upland flows and runoff from sources outside of the Project influence. The higher concentrations in the ponds may be a result of the physical conditions in the ponds which allow metals trapped in sediments to become soluble. There is the potential for these elements then to be released back into the river system. The effects of this are unknown, but Pinay et al. (1990) concluded that pollutants are removed in the hyporheic zone due to “filtration of solutes from groundwater as they move from fertilized agricultural lands through the hyporheic zone to the river, thereby reducing pollution loads.”

6.2.5 Project Effects on Pond Water Nutrient Parameters

There is no indication of Project impacts from nutrients upon the Oroville Wildlife Area ponds. All of the ponds exhibited higher concentrations of most nutrients when compared to Project waters.

6.3 SUMMARY OF PROJECT RELATED EFFECTS

Results from this study do not indicate any adverse effects to water levels or quality from Project operations. If there are any subtle effects to waters in the ponds, the effects would be beneficial since water quality within the Feather River is characterized as generally good.

7.0 REFERENCES

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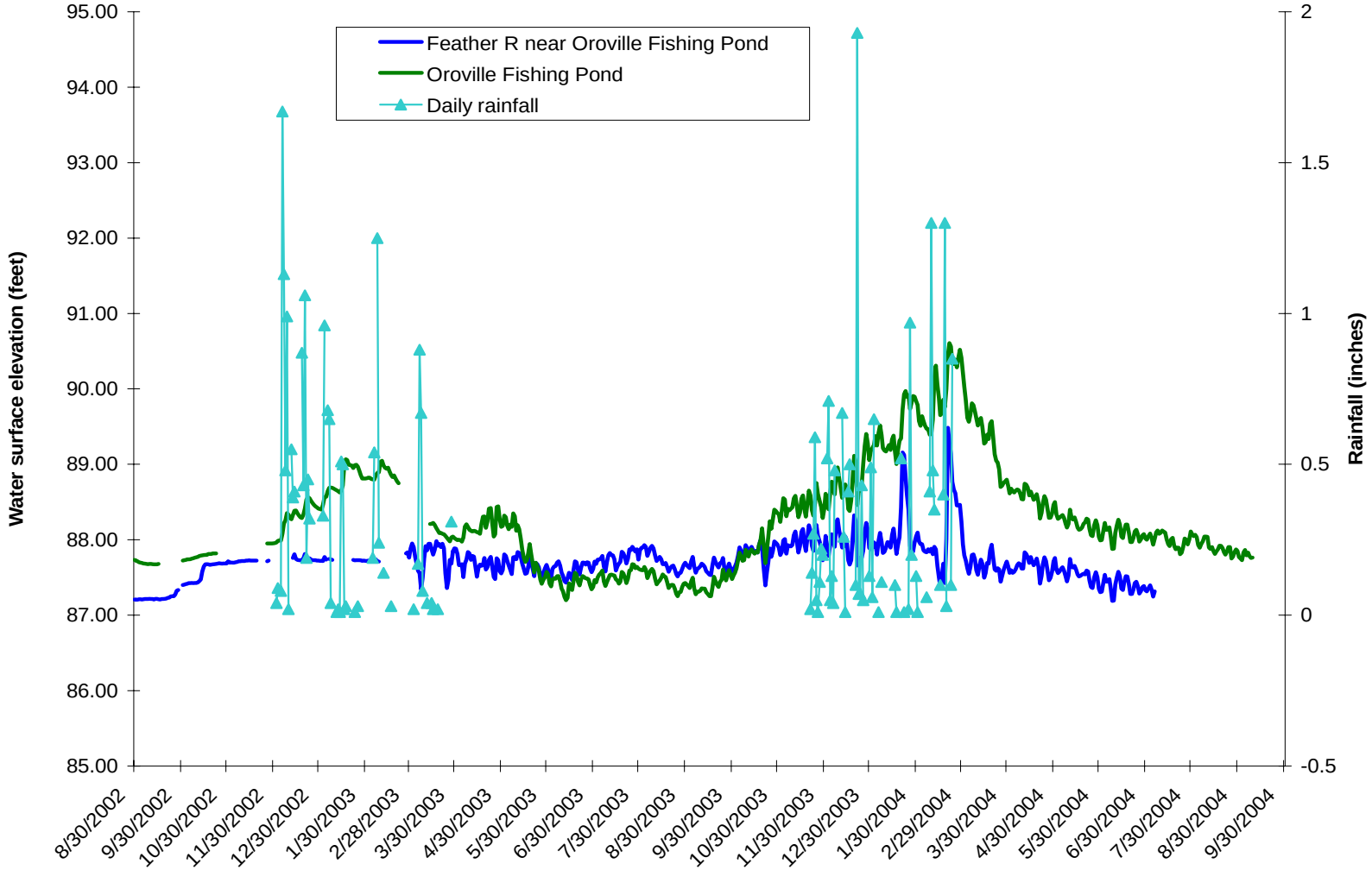
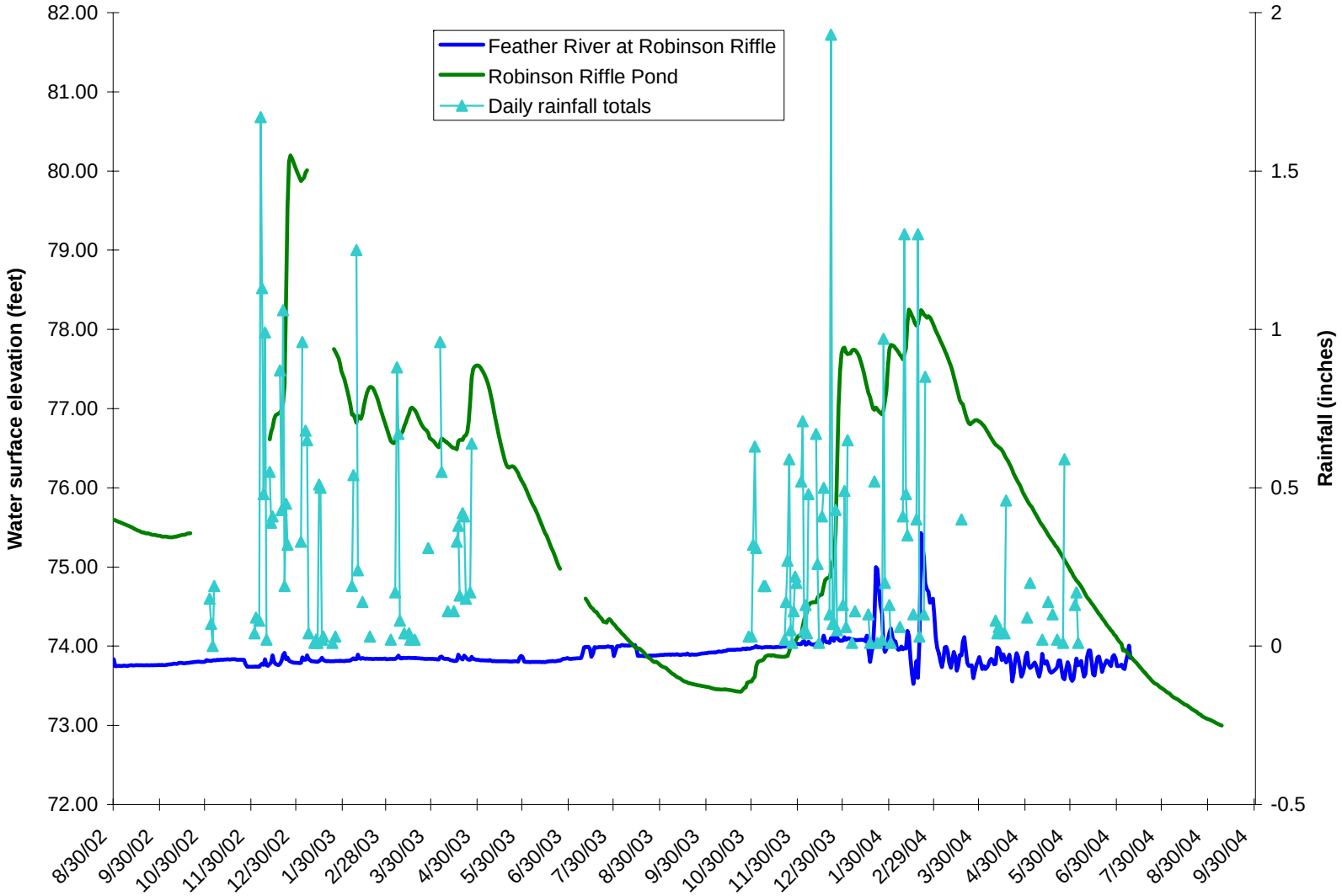
8.0 APPENDICES

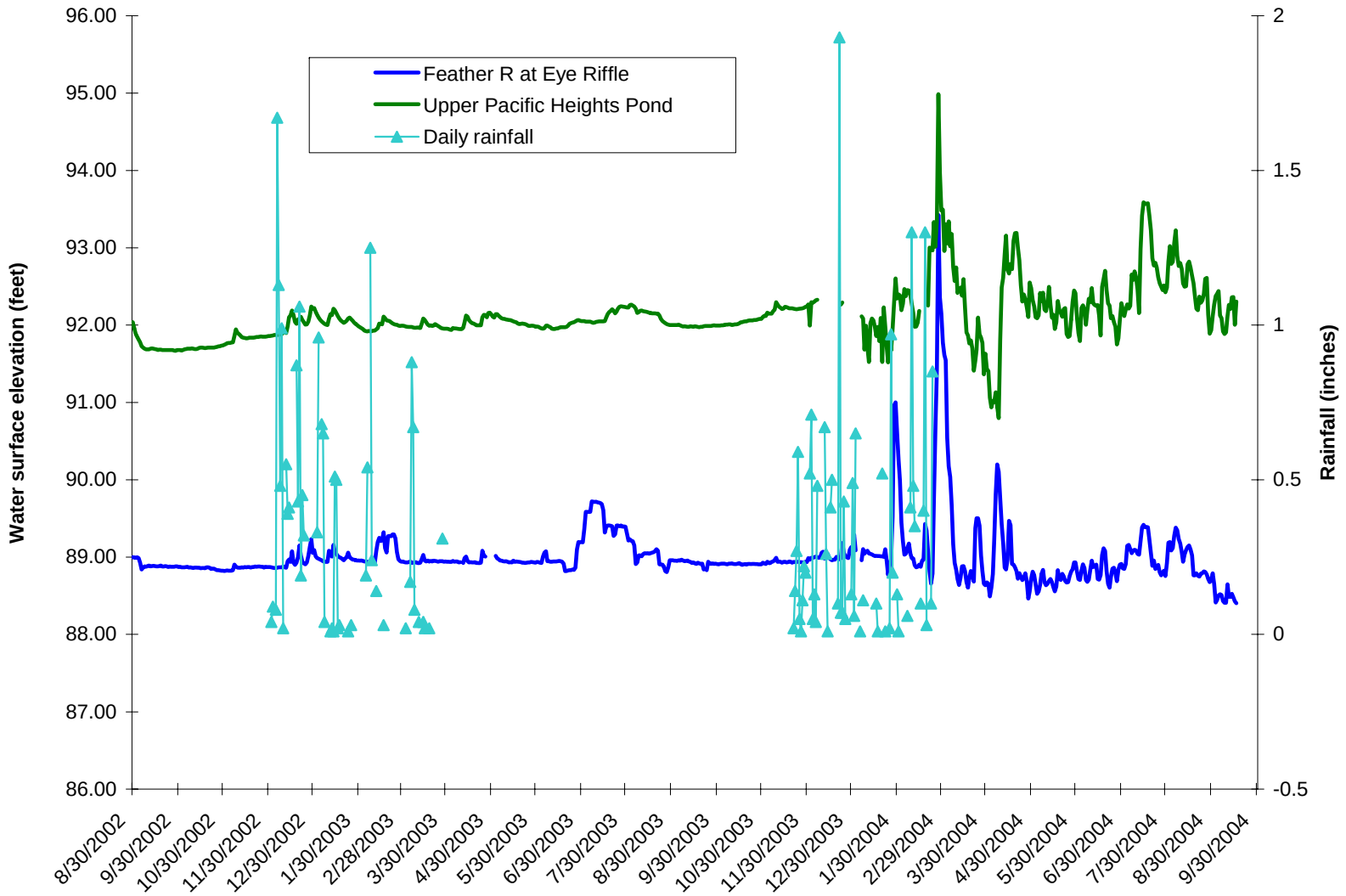
Appendix 1a. Oroville Fishing Pond Area Water Levels



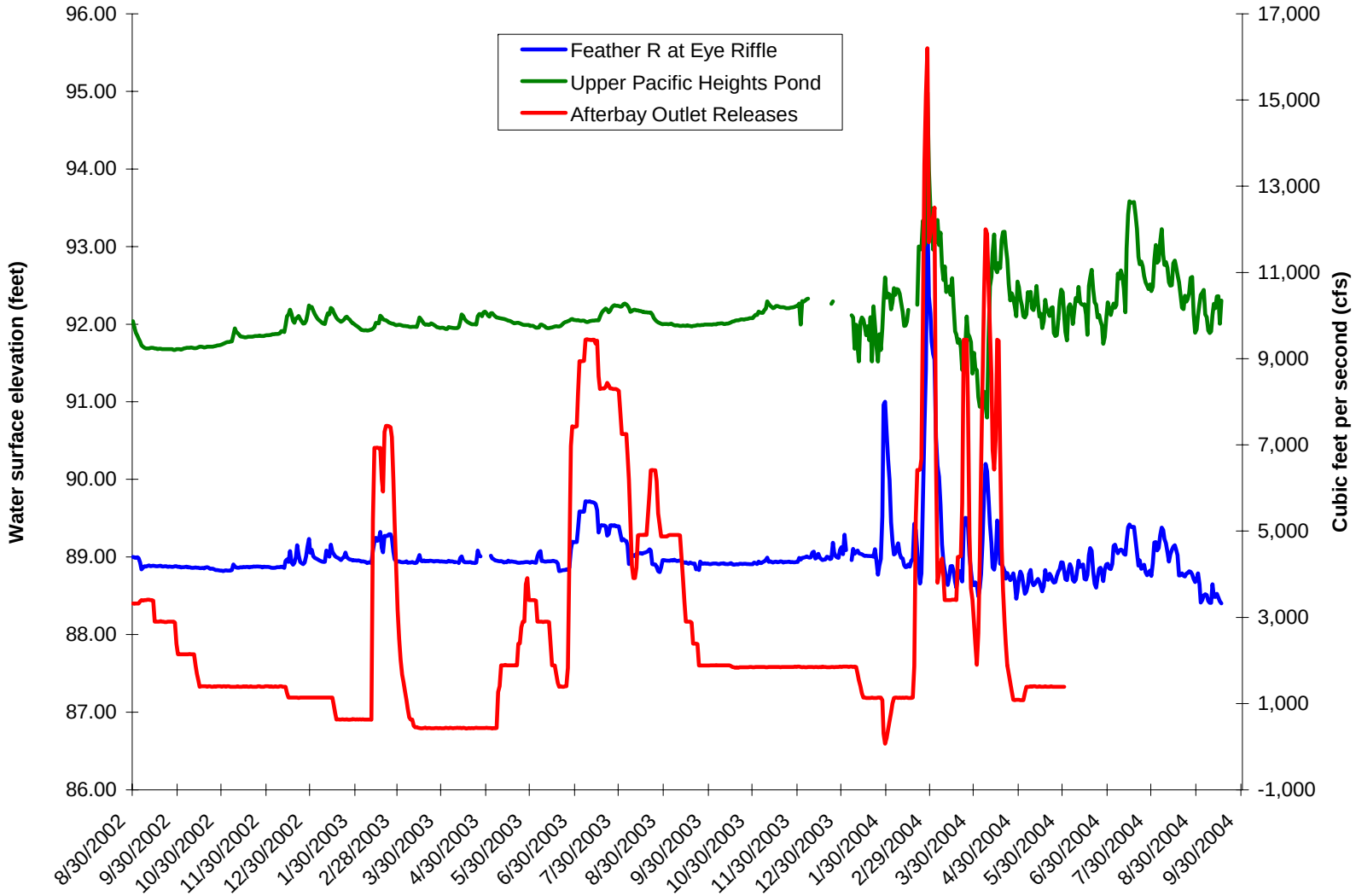
Appendix 1b. Robinson Riffle Area Water Levels



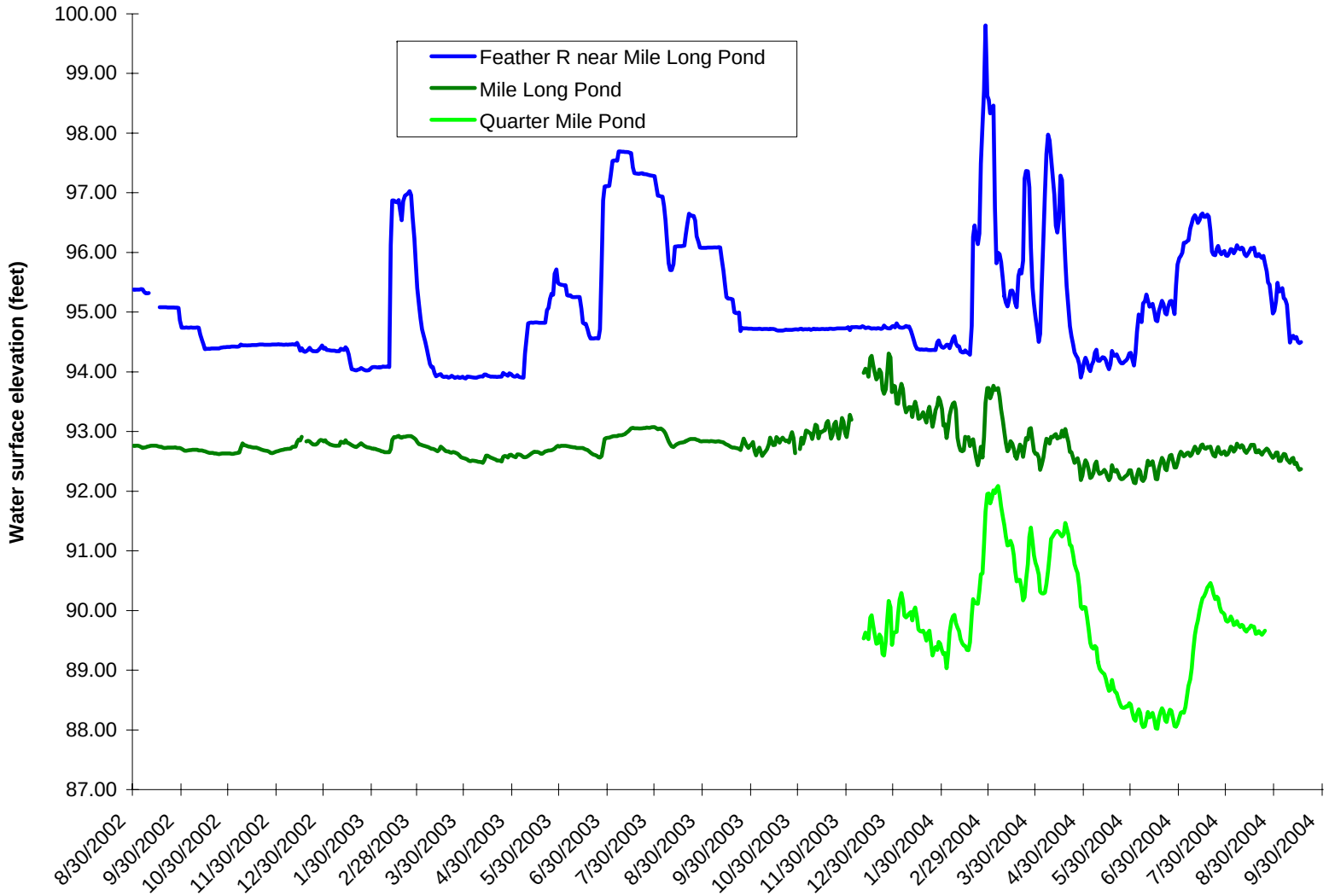
Appendix 1c. Upper Pacific Heights Area Water Levels.



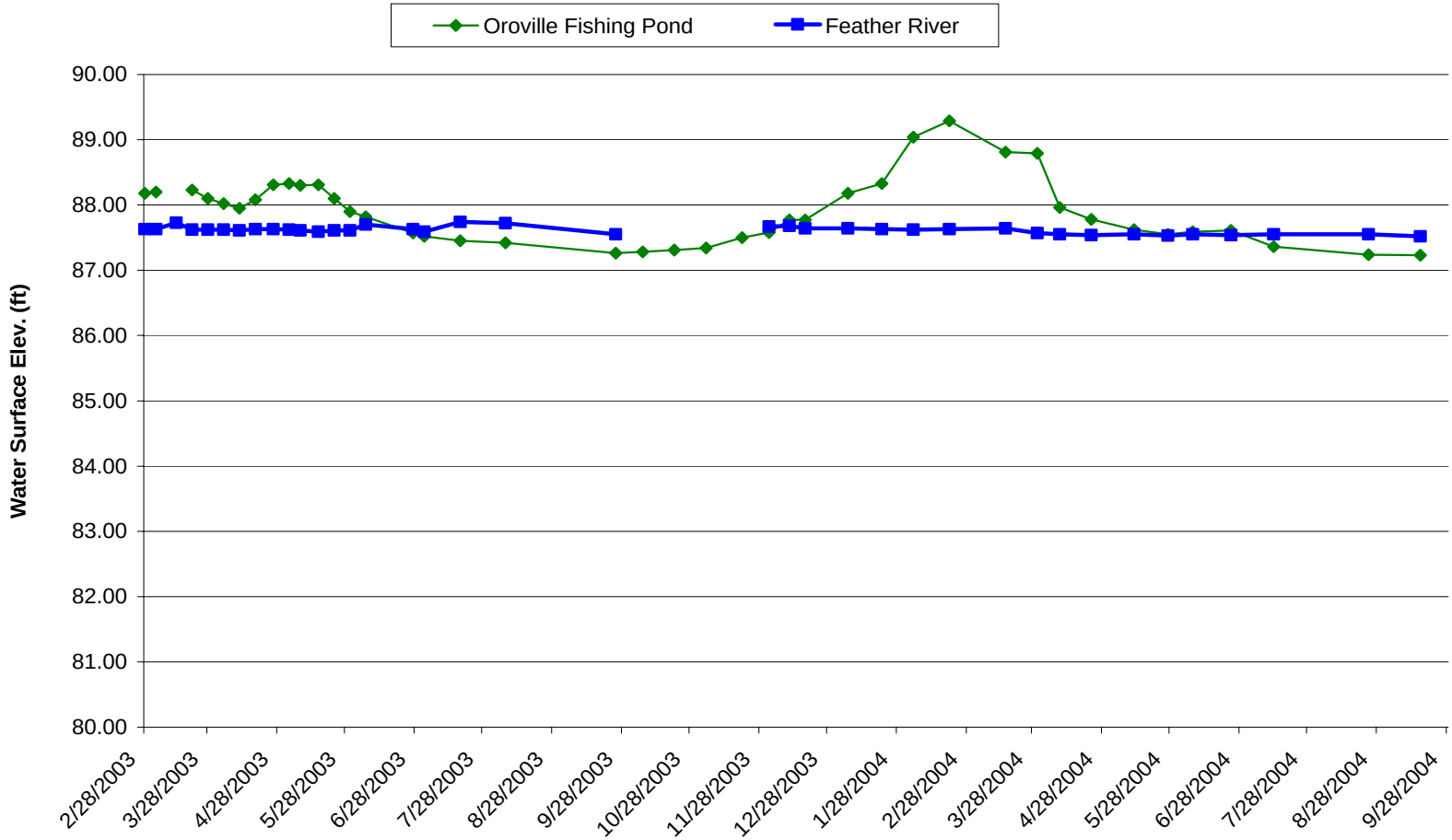
Appendix 1c. Continued.



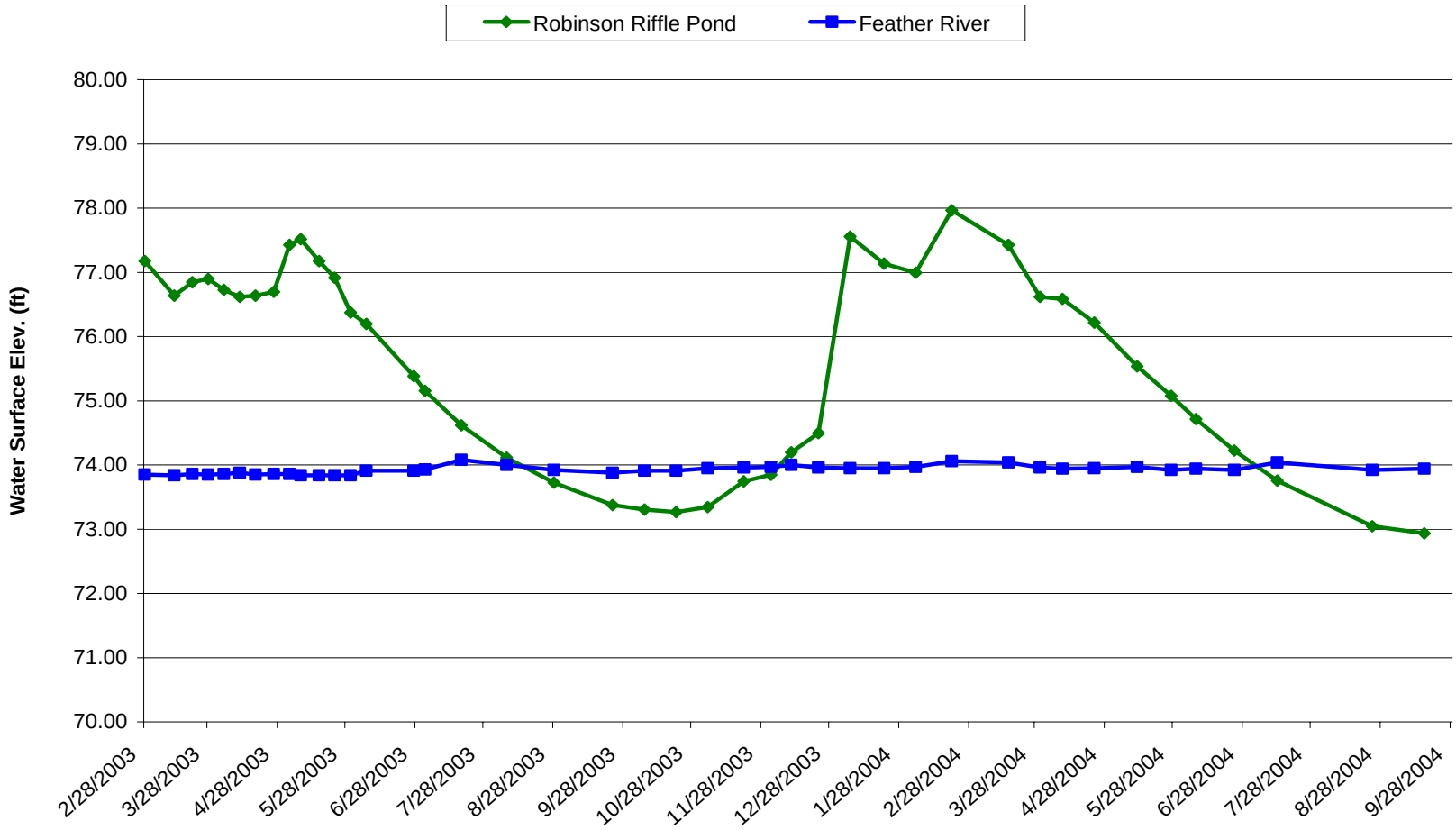
Appendix 1d. Mile Long Pond, Quarter Mile Pond, and Feather River Water Levels.



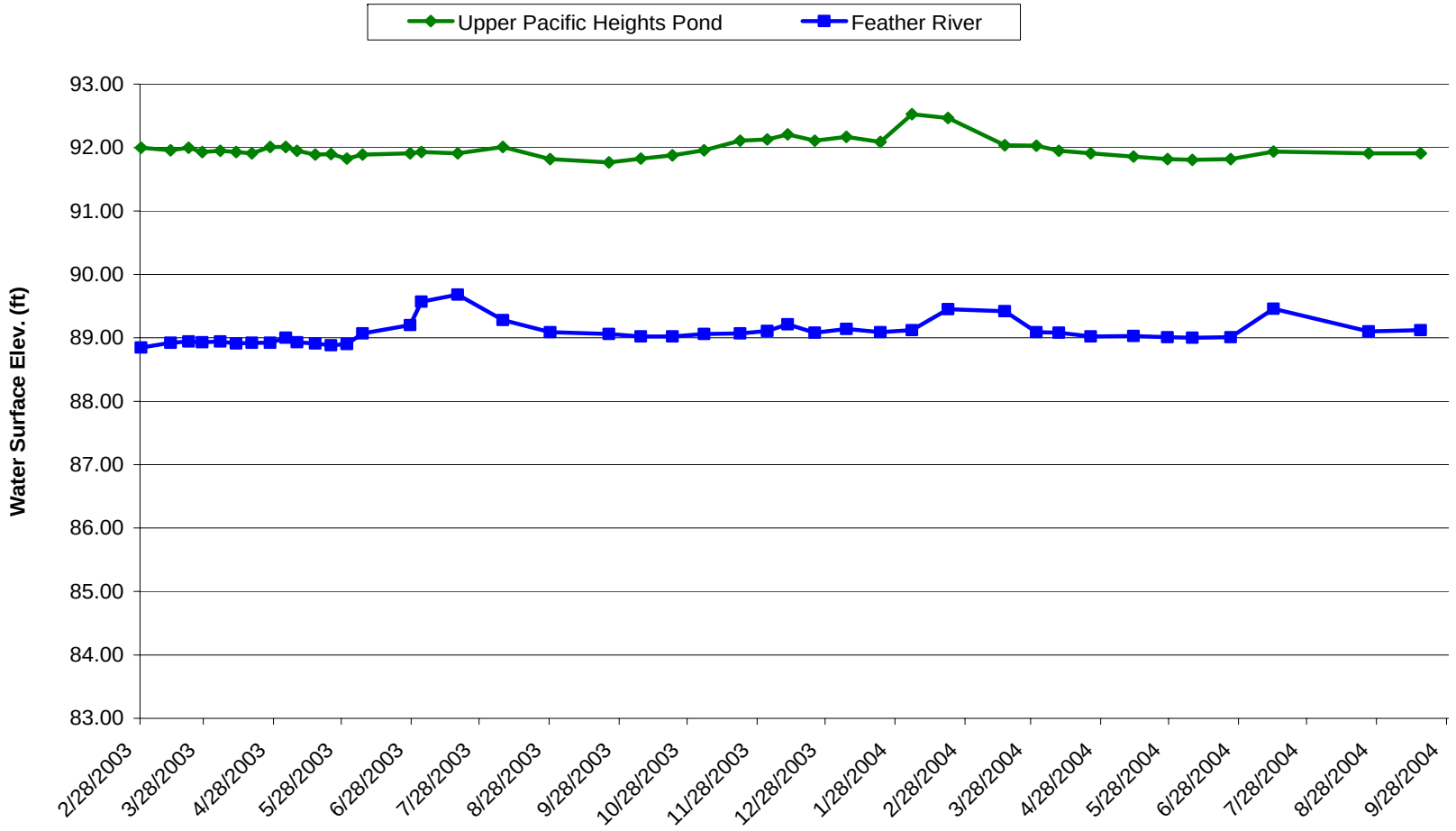
Appendix 2a. Oroville Fishing Pond Area staff gages.



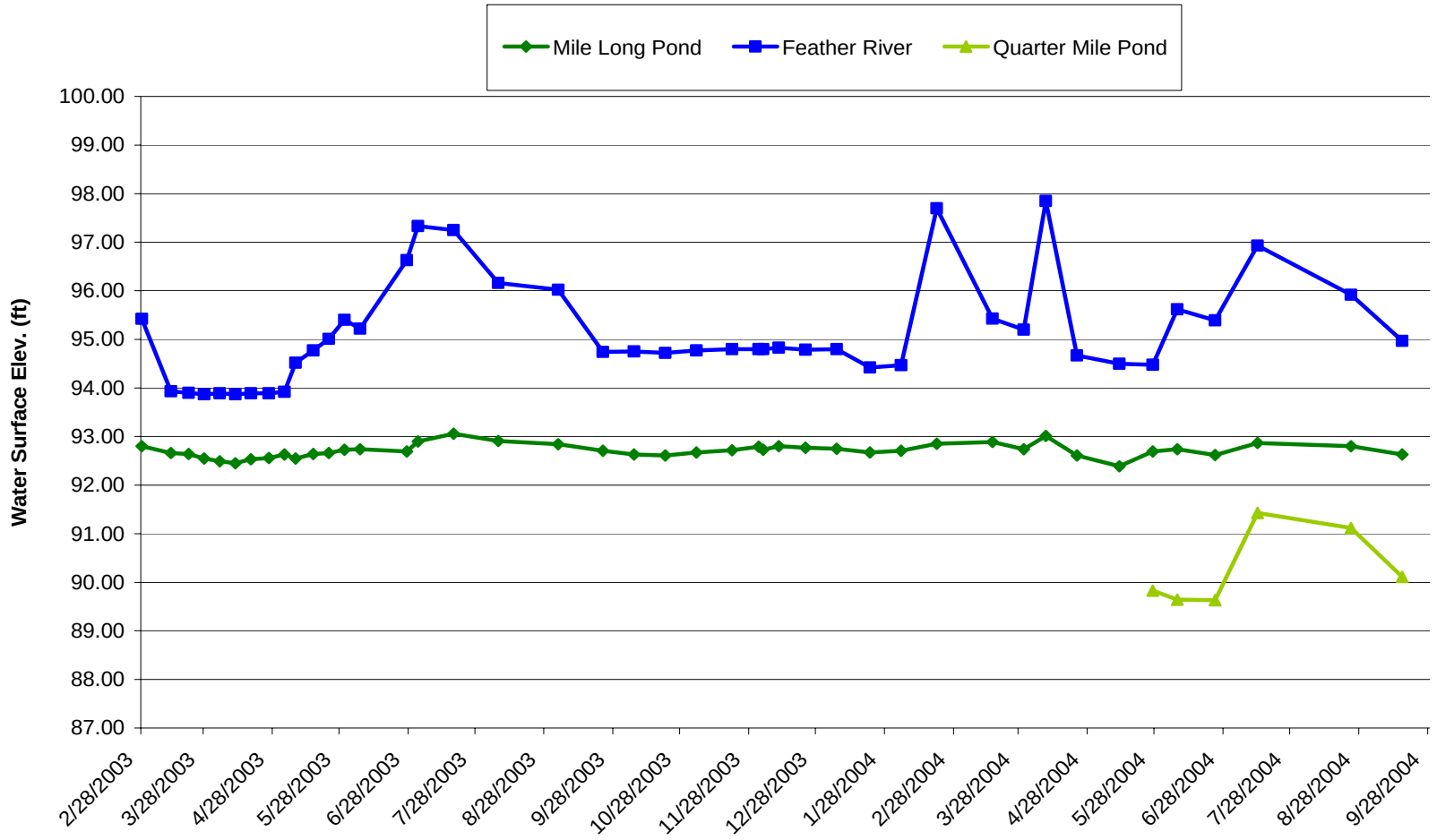
Appendix 2b. Robinson Riffle Area staff gages.



Appendix 2c. Upper Pacific Heights Area staff gages.



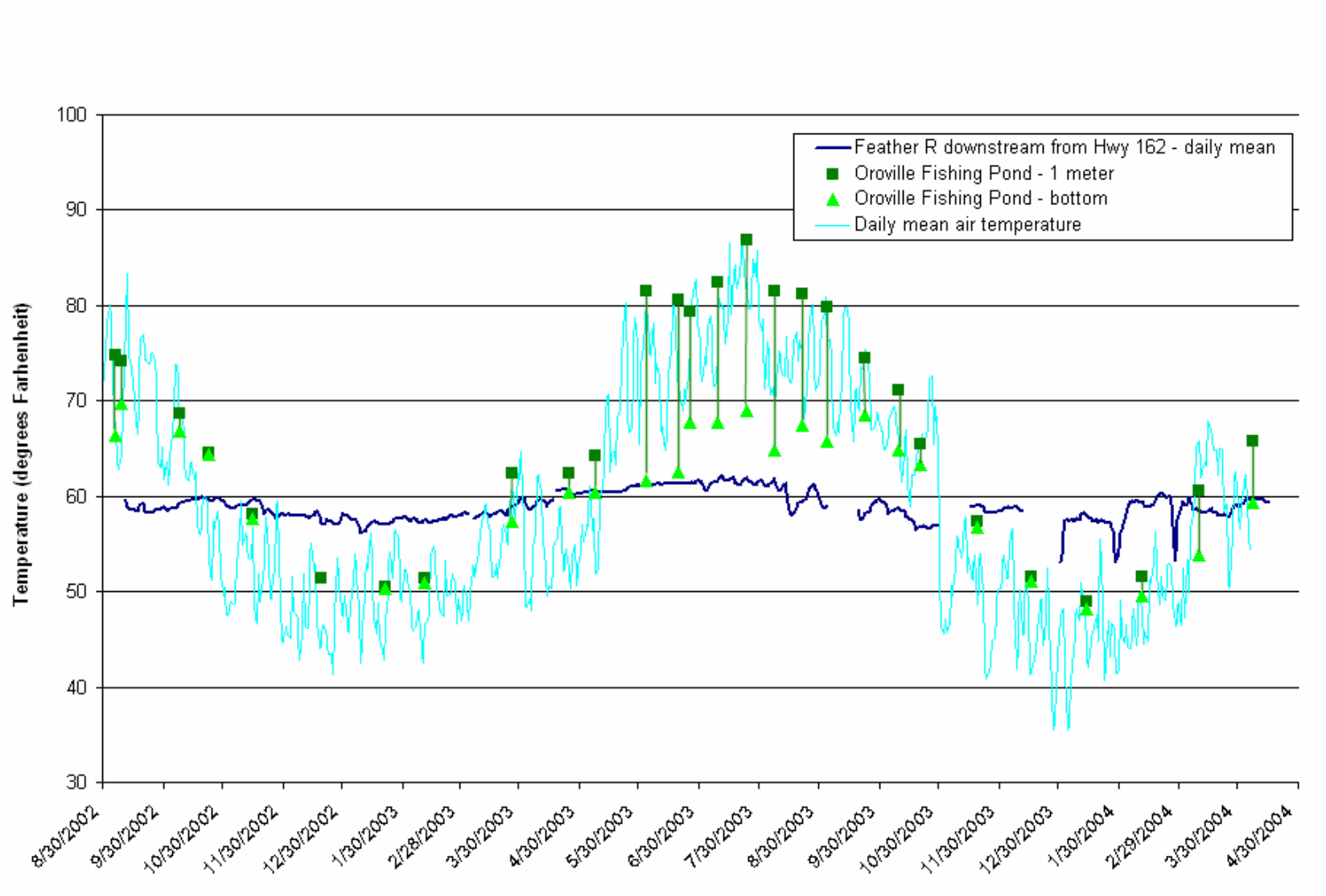
Appendix 2d. Mile Long Pond, Quarter Mile Pond, and Feather River staff gages.


Mile Long Pond
Feather River
Quarter Mile Pond
Water Surface Elev. (ft)
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
92.00
91.00
90.00
89.00
88.00
87.00
2/28/2003
3/28/2003
4/28/2003
5/28/2003
6/28/2003
7/28/2003
8/28/2003
9/28/2003
10/28/2003
11/28/2003
12/28/2003
1/28/2004
2/28/2004
3/28/2004
4/28/2004
5/28/2004
6/28/2004
7/28/2004
8/28/2004
9/28/2004

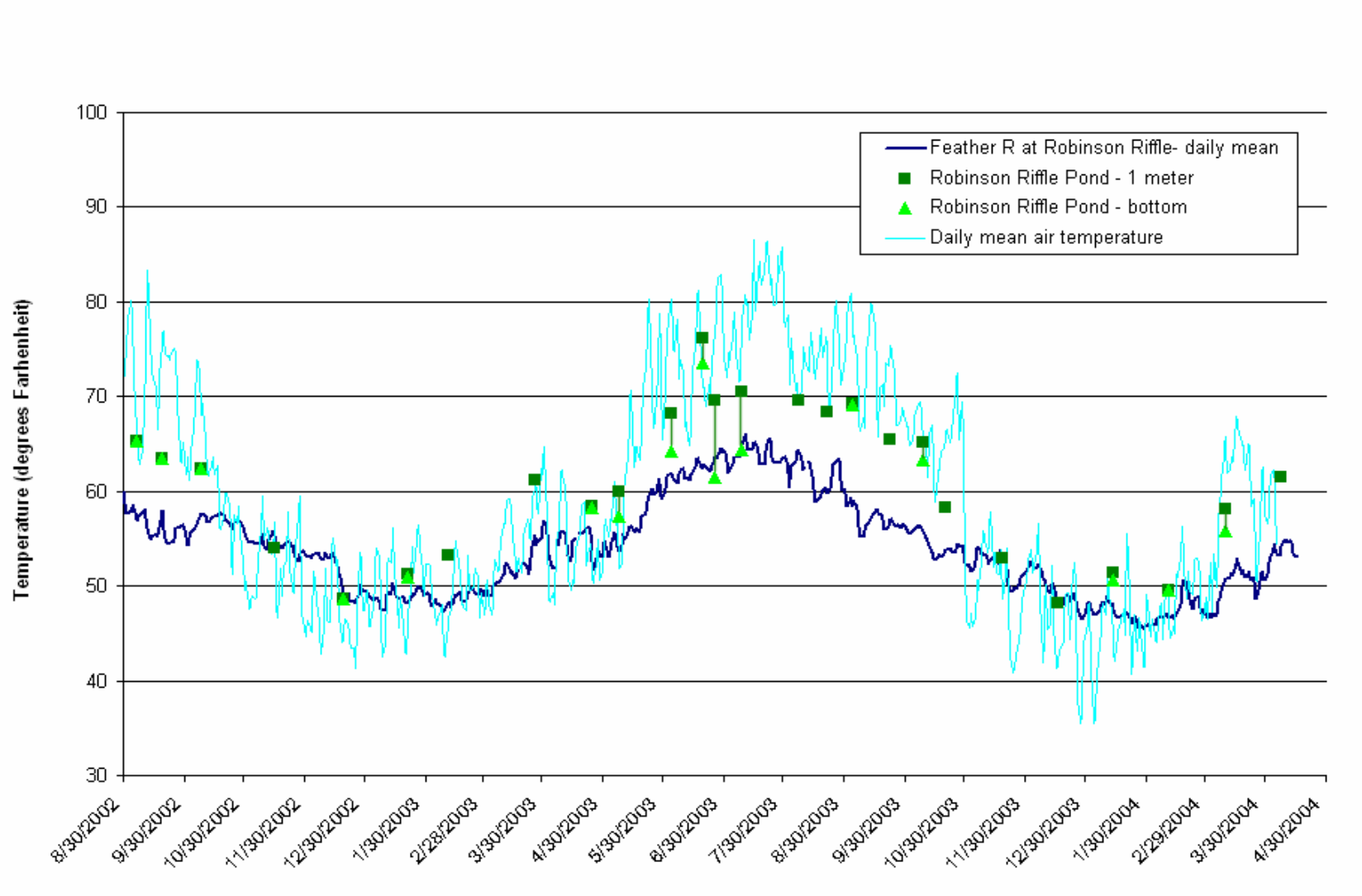
Appendix 2e. Additional staff gages installed April 2004.

Station	Date	Time	Staff #1	Staff #2	Staff #3
Pond 1	4/9/2004	0940	2		
Pond 1	4/23/2004	1055	0.55		
Pond 1	5/12/2004	0945	staff gone, stolen		
Pond 1	5/27/2004	0915		1.5	
Pond 1	6/7/2004	0955		1.15	
Pond 1	6/24/2004	1020		0.79	
Pond 1	7/13/2004	0820		0.81	
Pond 1	8/24/2004	1330		0.44	
Pond 1	9/16/2004	1230		0.05	
Pond 2	4/9/2004	1010	2		
Pond 2	4/23/2004	1050	1.92		
Pond 2	5/12/2004	0940	1.08		
Pond 2	5/27/2004	0910	0.52		
Pond 2	6/7/2004	0950	0.19		
Pond 2	6/24/2004	1030	out of water		
Pond 2	7/13/2004	0815	out of water	1.5	
Pond 2	8/24/2004	1320	out of water	1.03	
Pond 2	9/16/2004	1240	out of water	0.67	
Pond 3	4/9/2004	0740	2		
Pond 3	4/23/2004	0930	1.31		
Pond 3	5/12/2004	0920	0.41		
Pond 3	5/27/2004	0835	0.31		
Pond 3	6/7/2004	0930	0.45		
Pond 3	6/24/2004	0945	0.78		
Pond 3	7/13/2004	0745	1.6		
Pond 3	8/24/2004	1300	staff gone, stolen		
Pond 3	9/16/2004		staff gone, stolen		
Quarter Mile Pond	4/9/2004	0740	2		
Quarter Mile Pond	4/23/2004	0900	1.7		
Quarter Mile Pond	5/12/2004	0915	out of water		
Quarter Mile Pond	5/27/2004	0820	out of water	1	
Quarter Mile Pond	6/7/2004	0900		0.81	
Quarter Mile Pond	6/24/2004	0930		0.8	
Quarter Mile Pond	7/13/2004	0700		2.6	
Quarter Mile Pond	8/24/2004	0700		2.29	
Quarter Mile Pond	9/16/2004	1115		1.28	
Pond 5	4/9/2004	1130	2		
Pond 5	4/23/2004	1130	1.42		
Pond 5	5/12/2004	1025	0.45		
Pond 5	5/27/2004	1015	out of water	1	
Pond 5	6/7/2004	1020		0.42	
Pond 5	6/24/2004	1100	out of water	out of water	
Pond 5	7/13/2004	1015	out of water	out of water	1.5
Pond 5	8/24/2004	1100	out of water	out of water	out of water
Pond 5	9/16/2004	1040	out of water	out of water	out of water

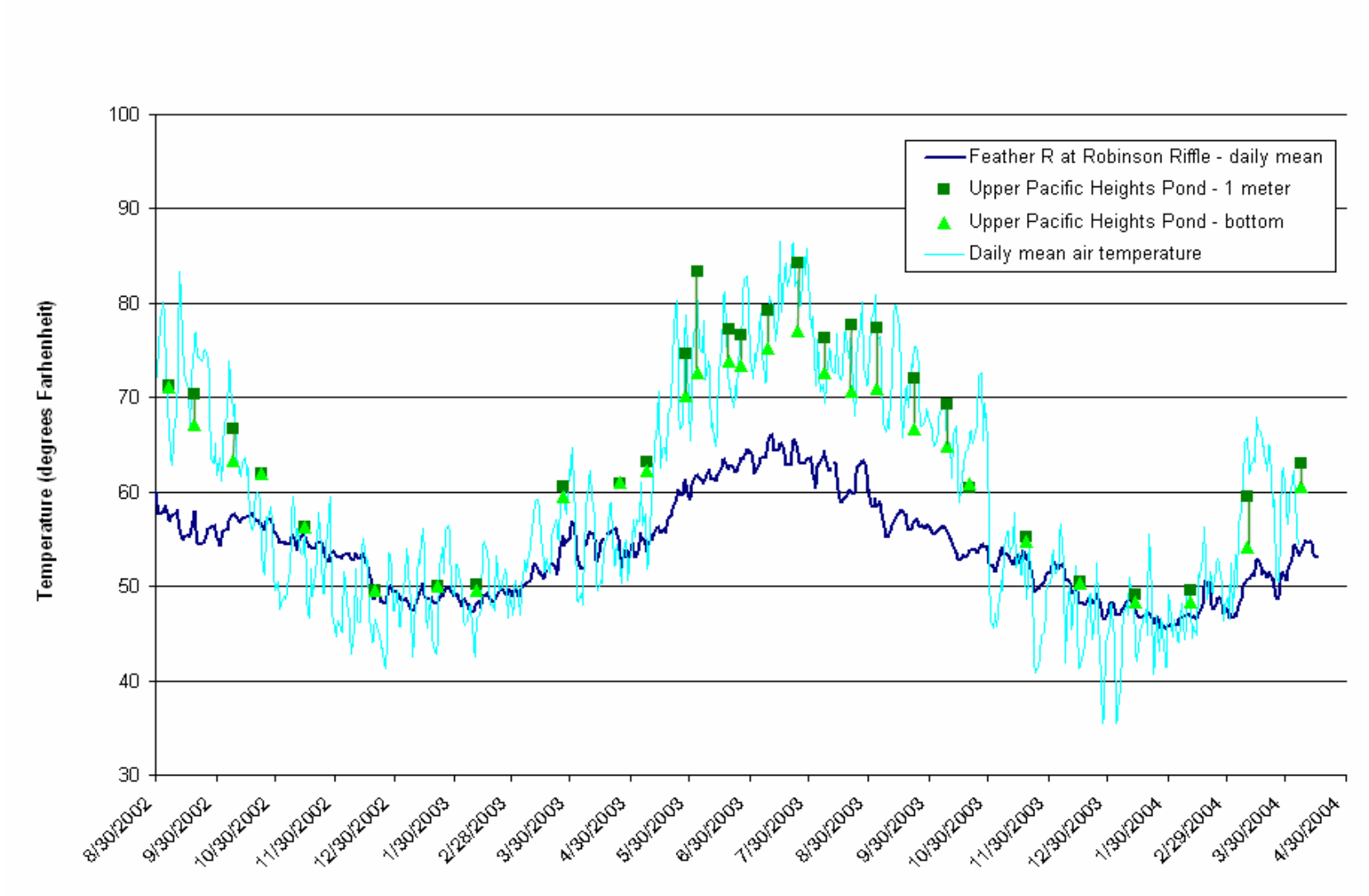
Appendix 3. Water temperatures from the Feather River and Oroville Wildlife Area Ponds.



Appendix 3. Continued.



Appendix 3. Continued.



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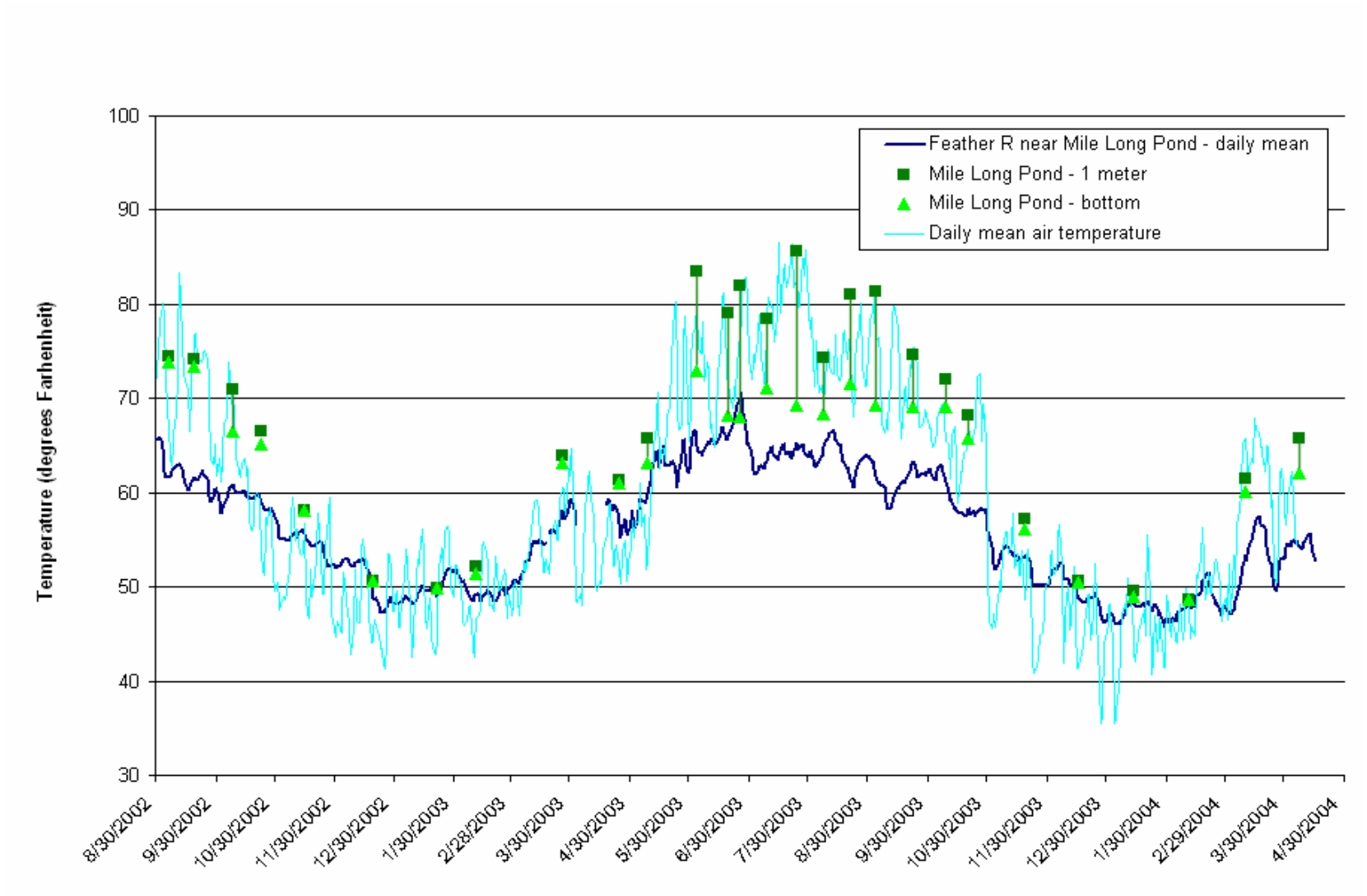
Temperature (degrees Farhenheit)
100
90
80
70
60
50
40
30
Feather R near Mile Long Pond - daily mean
Mile Long Pond - 1 meter
Mile Long Pond - bottom
Daily mean air temperature
8/30/2002
9/30/2002
10/30/2002
11/30/2002
12/30/2002
1/30/2003
2/28/2003
3/30/2003
4/30/2003
5/30/2003
6/30/2003
7/30/2003
8/30/2003
9/30/2003
10/30/2003
11/30/2003
12/30/2003
1/30/2004
2/29/2004
3/30/2004
4/30/2004

Appendix 4. Summary of physical parameter numerical limits for The Feather River and Oroville Wildlife Area Ponds.

Feather R DS HWY 162 (A5-1740.50)

	Dissolved Oxygen (ppm)	pH units	Conductivity (field) umhos/cm	Conductivity (lab) umhos/cm	Alkalinity mg/L	Turbidity NTU
Maximum detected	12	7.5	111	106	52	8.2
Minimum detected	8.4	7.1	79	61	40	0.6
Number of samples	30	30	30	30	28	30
Number of samples exceeding criteria or objectives						
Primary MCL[1]	-	-	-	-	-	3
Secondary MCL[1]	-	0	0	0	-	3
Agricultural Goal[2]	-	0	0	0	-	-
NAWQC[3] Humans	-	0	-	-	-	-
NAWQC[3] Aquatic Life	-	0	-	-	0	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	-	3
Basin Plan[7]	0	0	0	0	-	-

Oroville Fishing Pond (A5L92951347)

	Dissolved Oxygen (ppm)	pH units	Conductivity (field) umhos/cm	Conductivity (lab) umhos/cm	Alkalinity mg/L	Turbidity NTU	Secchi depth (m)
Maximum detected	13.5	8.7	395	386	182.0	12.0	2.8
Minimum detected	4.4	7.4	91	315	146.0	1.3	0.4
Number of samples	36	26	26	26	23	21	28
Number of samples exceeding criteria or objectives							
Primary MCL[1]	-	-	-	-	-	7	-
Secondary MCL[1]	-	0	0	0	-	7	-
Agricultural Goal[2]	-	0	0	0	-	-	-
NAWQC[3] Humans	-	0	-	-	-	-	-
NAWQC[3] Aquatic Life	-	0	-	-	0	-	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	-	-	-

Robinson Riffle Pond (A5L92821359)

	Dissolved Oxygen (ppm)	pH units	Conductivity (field) umhos/cm	Conductivity (lab) umhos/cm	Alkalinity mg/L	Turbidity NTU	Secchi depth (m)
Maximum detected	13.5	9.0	388	313	162.0	47.5	2.3
Minimum detected	0.4	6.8	125	129	59.0	1.2	0
Number of samples	35	25	25	24	21	23	12
Number of samples exceeding criteria or objectives							
Primary MCL[1]	-	-	-	-	-	14	-
Secondary MCL[1]	-	1	0	0	-	14	-
Agricultural Goal[2]	-	1	0	0	-	-	-
NAWQC[3] Humans	-	0	-	-	-	-	-
NAWQC[3] Aquatic Life	-	0	-	-	0	-	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	-	-	-

Appendix 4. Continued.

Feather R A Robinson Riffle (A5-1712.50)

	Dissolved Oxygen (ppm)	pH units	Conductivity (field) umhos/cm	Conductivity (lab) umhos/cm	Alkalinity mg/L	Turbidity NTU
Maximum detected	13.1	8.1	114	107	50	23.1
Minimum detected	7.6	7	80	62	37	0.4
Number of samples	30	30	30	30	28	30
Number of samples exceeding criteria or objectives						
Primary MCL[1]	-	-	-	-	-	3
Secondary MCL[1]	-	0	0	0	-	3
Agricultural Goal[2]	-	0	0	0	-	-
NAWQC[3] Humans	-	0	-	-	-	-
NAWQC[3] Aquatic Life	-	0	-	-	0	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	-	3
Basin Plan[7]	1[10]	0	0	0	-	-

Upper Pacific Heights Pond (A5L92771367)

	Dissolved Oxygen (ppm)	pH units	Conductivity (field) umhos/cm	Conductivity (lab) umhos/cm	Alkalinity mg/L	Turbidity NTU	Secchi depth (m)
Maximum detected	12.5	8.1	111	107	59.0	1.5	5.5
Minimum detected	0.4	7.2	35	47	23.0	0.5	2.6
Number of samples							30
Number of samples exceeding criteria or objectives							
Primary MCL[1]	-	-	-	-	-	0	-
Secondary MCL[1]	-	0	0	0	-	0	-
Agricultural Goal[2]	-	0	0	0	-	-	-
NAWQC[3] Humans	-	0	-	-	-	-	-
NAWQC[3] Aquatic Life	-	0	-	-	0	-	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	-	0	-

Feather R US from Afterbay Outlet (A5-1695.50)

	Dissolved Oxygen (ppm)	pH units	Conductivity (field) umhos/cm	Conductivity (lab) umhos/cm	Alkalinity mg/L	Turbidity NTU
Maximum detected	14.8	8.1	109	104	50	11.4
Minimum detected	8.7	7.2	80	65	40	0.6
Number of samples	31	30	30	30	29	30
Number of samples exceeding criteria or objectives						
Primary MCL[1]	-	-	-	-	-	3
Secondary MCL[1]	-	0	0	0	-	3
Agricultural Goal[2]	-	0	0	0	-	-
NAWQC[3] Humans	-	0	-	-	-	-
NAWQC[3] Aquatic Life	-	0	-	-	0	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	-	3
Basin Plan[7]	0	0	0	0	-	-

Appendix 4. Continued.

Mile Long Pond - Sfc (A5L92541377)

	Dissolved Oxygen (ppm)	pH units	Conductivity (field) umhos/cm	Conductivity (lab) umhos/cm	Alkalinity mg/L	Turbidity NTU	Secchi depth (m)
Maximum detected	16.7	8.1	113	114	60.0	121.0	4.4
Minimum detected	9.4	7.2	54	54	26.0	0.7	0.6
Number of samples	24	24	24	24	24	24	29
Number of samples exceeding criteria or objectives							
Primary MCL[1]	-	-	-	-	-	3	-
Secondary MCL[1]	-	0	0	0	-	3	-
Agricultural Goal[2]	-	0	0	0	-	-	-
NAWQC[3] Humans	-	0	-	-	-	-	-
NAWQC[3] Aquatic Life	-	0	-	-	0	-	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	-	3	-

Mile Long Pond - Btm (A5L92541377)

	Dissolved Oxygen (ppm)	pH units	Conductivity (field) umhos/cm	Conductivity (lab) umhos/cm	Alkalinity mg/L	Turbidity NTU
Maximum detected	13.2	8.4	169	171	75.0	23.2
Minimum detected	8.9	7.2	63	64	30.0	0.2
Number of samples	27	27	27	27	27	27
Number of samples exceeding criteria or objectives						
Primary MCL[1]	-	-	-	-	-	1
Secondary MCL[1]	-	0	0	0	-	1
Agricultural Goal[2]	-	0	0	0	-	-
NAWQC[3] Humans	-	0	-	-	-	-
NAWQC[3] Aquatic Life	-	0	-	-	0	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	-	2

Feather R NR Mile Long Pond (A5-1662.50)

	Dissolved Oxygen (ppm)	pH units	Conductivity (field) umhos/cm	Conductivity (lab) umhos/cm	Alkalinity mg/L	Turbidity NTU
Maximum detected	14.5	8.3	104	100	52	6.2
Minimum detected	9.7	7.2	78	60	38	0.7
Number of samples	30	30	29	30	28	29
Number of samples exceeding criteria or objectives						
Primary MCL[1]	-	-	-	-	-	1
Secondary MCL[1]	-	0	0	0	-	1
Agricultural Goal[2]	-	0	0	0	-	-
NAWQC[3] Humans	-	0	-	-	-	-
NAWQC[3] Aquatic Life	-	0	-	-	0	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	-	2
Basin Plan[7]	0	0	0	0	-	-

Appendix 4. Continued.

Footnotes

1. California Department of Health Services, California Code of Regulations, Title 22, Division 4, Chapter 15, Domestic Water Quality and Monitoring
2. Food and Agriculture Organization of the United Nations, 1985. Water Quality for Agriculture.
3. U.S. Environmental Protection Agency, Quality Criteria for Water, 1986 (May 1986) [The Gold Book] plus updates (various dates)
4. U.S. Environmental Protection Agency, Ambient Water Quality Criteria Recommendations for both Rivers and Streams in Ecoregion 1. 2001. EPA 822-B-01-012
5. Chronic (4 day average)
6. Acute (1 hr average)
7. The Water Quality Control Plan (Basin Plan) for the California Regional Water Quality Control Board, Central Valley Region, Fourth edition. The Sacramento River Basin and the San Joaquin River Basin. Central Valley Regional Water Quality Control Board. Sacramento, California.
8. For Waters designated WARM (not <5.0 mg/L).
9. For Waters designated COLD/SPAWN (not <7.0 mg/L).
10. For the Feather River from Fish Barrier Dam at Oroville to Honcut Creek (September 1 to May 31) (not <8.0 mg/L).

Appendix 5. Summary of mineral parameter numerical limits for The Feather River and Oroville Wildlife Area Ponds.

Feather R DS HWY 162 (A5-1740.50)

	Calcium		Magnesium		Sodium	Potassium	Sulfate	Chloride	Boron	Hardness	
	T	D	T	D	D	D	D	D	D	T	D
Maximum detected	9	10	5	5	4	1.0	3	2	<0.1	46	46
Minimum detected	7	7	3	3	3	0.6	2	<1.0	<0.1	30	30
Number of samples	17	29	17	29	29	29	29	29	29	29	29
Number of samples exceeding criteria or objectives											
USEPA - Taste and odor threshold[1]	-	-	-	-	0	-	-	-	-	-	-
Secondary MCL[2]	-	-	-	-	-	-	0	0	-	-	-
Agricultural Goal[3]	-	-	-	-	0	-	-	0	0	-	-
NAWQC[4] Aquatic Life	-	-	-	-	-	-	-	0	-	-	-
USEPA IRIS Reference Dose[5]	-	-	-	-	-	-	-	-	0	-	-
California DHS Action Level for drinking water [6]	-	-	-	-	-	-	-	-	0	-	-
USEPA draft Drinking Water Advisory [1]	-	-	-	-	0	-	-	-	-	-	-
USEPA Proposed MCL Goal[1]	-	-	-	-	-	-	0	-	-	-	-

Oroville Fishing Pond (A5L92951347)

	Calcium		Magnesium		Sodium	Potassium	Sulfate	Chloride	Boron	Hardness	
	T	D	T	D	D	D	D	D	D	T	D
Maximum detected	31	30	28	27	13	1.7	6	22	0.1	218	178
Minimum detected	20	20	21	19	10	1.4	2	12	<0.1	149	143
Number of samples	24	24	24	24	24	24	24	24	24	24	24
Number of samples exceeding criteria or objectives											
USEPA - Taste and odor threshold[1]	-	-	-	-	0	-	-	-	-	-	-
Secondary MCL[2]	-	-	-	-	-	-	0	0	-	-	-
Agricultural Goal[3]	-	-	-	-	0	-	-	0	0	-	-
NAWQC[4] Aquatic Life	-	-	-	-	-	-	-	0	-	-	-
USEPA IRIS Reference Dose[5]	-	-	-	-	-	-	-	-	0	-	-
California DHS Action Level for drinking water [6]	-	-	-	-	-	-	-	-	0	-	-
USEPA draft Drinking Water Advisory [1]	-	-	-	-	0	-	-	-	-	-	-
USEPA Proposed MCL Goal[1]	-	-	-	-	-	-	0	-	-	-	-

Feather R A Robinson Riffle (A5-1712.50)

	Calcium		Magnesium		Sodium	Potassium	Sulfate	Chloride	Boron	Hardness	
	T	D	T	D	D	D	D	D	D	T	D
Maximum detected	9	10	5	5	5	1.1	3	3	<0.1	43	43
Minimum detected	7	7	3	3	3	0.6	2	<1.0	<0.1	32	30
Number of samples	17	29	17	29	29	29	29	29	29	29	29
Number of samples exceeding criteria or objectives											
USEPA - Taste and odor threshold[1]	-	-	-	-	0	-	-	-	-	-	-
Secondary MCL[2]	-	-	-	-	-	-	0	0	-	-	-
Agricultural Goal[3]	-	-	-	-	0	-	-	0	0	-	-
NAWQC[4] Aquatic Life	-	-	-	-	-	-	-	0	-	-	-
USEPA IRIS Reference Dose[5]	-	-	-	-	-	-	-	-	0	-	-
California DHS Action Level for drinking water [6]	-	-	-	-	-	-	-	-	0	-	-
USEPA draft Drinking Water Advisory [1]	-	-	-	-	0	-	-	-	-	-	-
USEPA Proposed MCL Goal[1]	-	-	-	-	-	-	0	-	-	-	-

Appendix 5. Continued.

Robinson Riffle Pond (A5L92821359)

	Calcium		Magnesium		Sodium	Potassium	Sulfate	Chloride	Boron	Hardness	
	T	D	T	D	D	D	D	D	D	T	D
Maximum detected	29	28	21	22	9	3.0	4	9	<0.1	159	161
Minimum detected	9	9	7	7	4	<0.5	<1.0	2	<0.1	51	51
Number of samples	24	24	24	24	24	24	24	24	24	24	24
Number of samples exceeding criteria or objectives											
USEPA - Taste and odor threshold[1]	-	-	-	-	0	-	-	-	-	-	-
Secondary MCL[2]	-	-	-	-	-	-	0	0	-	-	-
Agricultural Goal[3]	-	-	-	-	0	-	-	0	0	-	-
NAWQC[4] Aquatic Life	-	-	-	-	-	-	-	0	-	-	-
USEPA IRIS Reference Dose[5]	-	-	-	-	-	-	-	-	0	-	-
California DHS Action Level for drinking water [6]	-	-	-	-	-	-	-	-	0	-	-
USEPA draft Drinking Water Advisory [1]	-	-	-	-	0	-	-	-	-	-	-
USEPA Proposed MCL Goal[1]	-	-	-	-	-	-	0	-	-	-	-

Upper Pacific Heights Pond (A5L92771367)

	Calcium		Magnesium		Sodium	Potassium	Sulfate	Chloride	Boron	Hardness	
	T	D	T	D	D	D	D	D	D	T	D
Maximum detected	10	10	5	5	4	1.1	2	2	<0.1	46	46
Minimum detected	8	8	4	4	3	0.5	2	<1	<0.1	36	36
Number of samples	24	24	24	24	24	24	24	24	24	24	24
Number of samples exceeding criteria or objectives											
USEPA - Taste and odor threshold[1]	-	-	-	-	0	-	-	-	-	-	-
Secondary MCL[2]	-	-	-	-	-	-	0	0	-	-	-
Agricultural Goal[3]	-	-	-	-	0	-	-	0	0	-	-
NAWQC[4] Aquatic Life	-	-	-	-	-	-	-	0	-	-	-
USEPA IRIS Reference Dose[5]	-	-	-	-	-	-	-	-	0	-	-
California DHS Action Level for drinking water [6]	-	-	-	-	-	-	-	-	0	-	-
USEPA draft Drinking Water Advisory [1]	-	-	-	-	0	-	-	-	-	-	-
USEPA Proposed MCL Goal[1]	-	-	-	-	-	-	0	-	-	-	-

Feather R US from Afterbay Outlet (A5-1695.50)

	Calcium		Magnesium		Sodium	Potassium	Sulfate	Chloride	Boron	Hardness	
	T	D	T	D	D	D	D	D	D	T	D
Maximum detected	9	10	5	5	4	1.1	3	2	<0.1	46	43
Minimum detected	7	7	3	3	3	0.7	2	<1.0	<0.1	30	30
Number of samples	18	30	18	30	30	30	30	30	30	30	30
Number of samples exceeding criteria or objectives											
USEPA - Taste and odor threshold[1]	-	-	-	-	0	-	-	-	-	-	-
Secondary MCL[2]	-	-	-	-	-	-	0	0	-	-	-
Agricultural Goal[3]	-	-	-	-	0	-	-	0	0	-	-
NAWQC[4] Aquatic Life	-	-	-	-	-	-	-	0	-	-	-
USEPA IRIS Reference Dose[5]	-	-	-	-	-	-	-	-	0	-	-
California DHS Action Level for drinking water [6]	-	-	-	-	-	-	-	-	0	-	-
USEPA draft Drinking Water Advisory [1]	-	-	-	-	0	-	-	-	-	-	-
USEPA Proposed MCL Goal[1]	-	-	-	-	-	-	0	-	-	-	-

Appendix 5. Continued.

Mile Long Pond Surface (A59L92541377)

	Calcium		Magnesium		Sodium	Potassium	Sulfate	Chloride	Boron	Hardness	
	T	D	T	D	D	D	D	D	D	T	D
Maximum detected	12	12	6	6	5	1.2	2	2	<0.1	52	52
Minimum detected	8	8	4	4	3	<0.5	1	1	<0.1	39	36
Number of samples	24	24	24	24	24	24	24	24	24	24	24
Number of samples exceeding criteria or objectives											
USEPA - Taste and odor threshold[1]	-	-	-	-	0	-	-	-	-	-	-
Secondary MCL[2]	-	-	-	-	-	-	0	0	-	-	-
Agricultural Goal[3]	-	-	-	-	0	-	-	0	0	-	-
NAWQC[4] Aquatic Life	-	-	-	-	-	-	-	0	-	-	-
USEPA IRIS Reference Dose[5]	-	-	-	-	-	-	-	-	0	-	-
California DHS Action Level for drinking water [6]	-	-	-	-	-	-	-	-	0	-	-
USEPA draft Drinking Water Advisory [1]	-	-	-	-	0	-	-	-	-	-	-
USEPA Proposed MCL Goal[1]	-	-	-	-	-	-	0	-	-	-	-

Mile Long Pond Bottom (A59L92541377)

	Calcium		Magnesium		Sodium	Potassium	Sulfate	Chloride	Boron	Hardness	
	T	D	T	D	D	D	D	D	D	T	D
Maximum detected	14	14	10	10	6	1.5	2	4	<0.1	76	76
Minimum detected	8	8	4	4	3	<0.5	<1.0	1	<0.1	41	36
Number of samples	24	24	24	24	24	24	24	24	24	24	24
Number of samples exceeding criteria or objectives											
USEPA - Taste and odor threshold[1]	-	-	-	-	0	-	-	-	-	-	-
Secondary MCL[2]	-	-	-	-	-	-	0	0	-	-	-
Agricultural Goal[3]	-	-	-	-	0	-	-	0	0	-	-
NAWQC[4] Aquatic Life	-	-	-	-	-	-	-	0	-	-	-
USEPA IRIS Reference Dose[5]	-	-	-	-	-	-	-	-	0	-	-
California DHS Action Level for drinking water [6]	-	-	-	-	-	-	-	-	0	-	-
USEPA draft Drinking Water Advisory [1]	-	-	-	-	0	-	-	-	-	-	-
USEPA Proposed MCL Goal[1]	-	-	-	-	-	-	0	-	-	-	-

Feather R NR Mile Long Pond (A5-1662.50)

	Calcium		Magnesium		Sodium	Potassium	Sulfate	Chloride	Boron	Hardness	
	T	D	T	D	D	D	D	D	D	T	D
Maximum detected	9	9	4	4	4	1.1	4	2	<0.1	41	39
Minimum detected	7	7	3	3	3	0.6	2	<1.0	<0.1	30	30
Number of samples	17	29	17	29	29	29	29	29	29	29	29
Number of samples exceeding criteria or objectives											
USEPA - Taste and odor threshold[1]	-	-	-	-	0	-	-	-	-	-	-
Secondary MCL[2]	-	-	-	-	-	-	0	0	-	-	-
Agricultural Goal[3]	-	-	-	-	0	-	-	0	0	-	-
NAWQC[4] Aquatic Life	-	-	-	-	-	-	-	0	-	-	-
USEPA IRIS Reference Dose[5]	-	-	-	-	-	-	-	-	0	-	-
California DHS Action Level for drinking water [6]	-	-	-	-	-	-	-	-	0	-	-
USEPA draft Drinking Water Advisory [1]	-	-	-	-	0	-	-	-	-	-	-
USEPA Proposed MCL Goal[1]	-	-	-	-	-	-	0	-	-	-	-

Appendix 5. Continued.

Footnotes

1. U.S. Environmental Protection Agency, Office of Water, 2004 Edition of the Drinking Water Standards and Health Advisories. (Winter 2004). EPA 822-R-04-005.
2. California Department of Health Services, California Code of Regulations, Title 22, Division 4, Chapter 15, Domestic Water Quality and Monitoring
3. Food and Agriculture Organization of the United Nations, 1985. Water Quality for Agriculture.
4. U.S. Environmental Protection Agency, Quality Criteria for Water, 1986 (May 1986) [The Gold Book] plus updates (various dates).
5. U.S. Environmental Protection Agency, Integrated Risk Information System [IRIS] database
6. California Department of Health Services, Division of Drinking Water and Environmental Management, Drinking Water Action Levels (6 June 2003), http://www.dhs.cahwnet.gov/ps/ddwem.
7. Chronic (4 day average)
8. Acute (1 hr average)

Appendix 6. Summary of metal numerical limits for the Feather River and the Oroville Wildlife Area ponds (µg/L).

Feather R DS HWY 162 (A5-1740.50)

	Aluminum		Arsenic		Cadmium		Chromium		Copper		Iron		Mercury	Methyl Mercury	Manganese		Nickel		Lead		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D	T	D	T	D
Maximum detected	183	130	0.789	0.731	0.123	0.004	1.62	0.87	2.7	0.98	358	148	0.00308	0.00034	28.5	15.3	1.49	1.11	0.505	0.03	0.19	0.3	0.04	0.047	0.99	0.53
Minimum detected	12	2.1	0.333	0.263	<0.004	<0.004	0.07	<0.02	0.59	0.4	24.8	<3.98	0.00028	0.000025	2.36	0.11	0.48	0.3	0.006	<0.003	<0.04	<0.089	<0.006	<0.006	0.049	0.06
Number of samples	30	29	30	29	30	29	30	29	30	29	30	29	30	28	30	29	30	29	30	29	30	29	15	14	30	29
Number of samples exceeding criteria or objectives																										
Public Health Goal[1]	0	-	-	-	1	-	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL[2]	0	-	0	-	0	-	0	-	0	-	-	-	0	-	-	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL[2]	0	-	0	-	-	-	-	-	0	-	2	-	-	-	0	-	-	-	-	-	-	-	0	-	0	-
Agricultural Goal[3]	0	-	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor[4]	-	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR[5] Humans	-	-	-	-	-	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	-	-	-	-	-	-
CTR[5] Aquatic Life	-	-	-	0	0	0	-	0	0	0	-	-	-	-	-	-	-	0	0	0	-	-	0	0	0	0
NTR[6]	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC[7] Humans	-	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC[7] Aquatic Life	4[9]	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose[8]	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	0	-	0	-

Oroville Fishing Pond (A5L92951347)

	Aluminum		Arsenic		Cadmium		Chromium		Copper		Iron		Mercury	Methyl Mercury	Manganese		Nickel		Lead		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D	T	D	T	D
Maximum concentration	104	5.45	4.42	4.16	0.009	<0.003	4.41	0.03	0.97	0.44	526	275	0.0022	0.00013	173	81.3	1.51	1.49	0.131	0.028	0.59	0.68	0.063	0.008	1.51	1.39
Minimum concentration	<1.5	<0.1	0.72	0.65	<0.004	<0.003	<0.02	<0.07	0.03	0.06	22	<3.5	0.0003	<0.00002	9.18	0.25	<0.04	<0.04	<0.01	<0.01	<0.30	<0.30	<0.106	<0.001	0.14	0.1
Number of samples	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	12	12	24	24
Number of samples exceeding criteria or objectives																										
Public Health Goal[1]	0	-	-	-	0	-	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL[2]	0	-	0	-	0	-	0	-	0	-	-	-	0	-	-	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL[2]	0	-	-	-	-	-	-	-	0	-	6	-	-	-	15	-	-	-	-	-	-	-	0	-	0	-
Agricultural Goal[3]	0	-	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor[4]	-	-	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR[5] Humans	-	-	-	-	-	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	-	-	-	-	-	-
CTR[5] Aquatic Life	-	-	-	0	0	0	-	0	0	0	-	-	-	-	-	-	-	0	0	0	-	-	0	0	0	0
NTR[6]	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC[7] Humans	-	-	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC[7] Aquatic Life	1[9]	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose[8]	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	0	-	0	-

Appendix 6. Continued.

Feather R A Robinson Riffle (A5-1712.50)

	Aluminum		Arsenic		Cadmium		Chromium		Copper		Iron		Mercury	Methyl Mercury	Manganese		Nickel		Lead		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D	T	D	T	D
Maximum detected	555	224	1.52	1.4	0.109	0.034	2.2	1.88	2.79	2.61	597	244	0.0145	0.000225	18.4	8.13	2.55	2.52	0.49	0.338	0.258	0.1	0.071	0.052	2.8	2.34
Minimum detected	9.53	1.5	0.346	0.29	<0.004	<0.004	0.11	<0.02	0.58	0.44	16.9	4.6	0.0003	0.000027	1.49	0.1	0.4	0.27	<0.011	<0.001	<0.04	<0.089	<0.006	<0.001	0.052	0.05
Number of samples	29	29	29	29	29	29	29	29	29	29	29	29	29	28	29	29	29	29	29	29	29	29	14	14	29	29
Number of samples exceeding criteria or objectives																										
Public Health Goal[1]	0	-	-	-	1	-	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL[2]	0	-	0	-	0	-	0	-	0	-	-	-	0	-	-	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL[2]	3	-	0	-	-	-	-	-	0	-	2	-	-	-	0	-	-	-	-	-	-	-	0	-	0	-
Agricultural Goal[3]	0	-	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor[4]	-	-	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR[5] Humans	-	-	-	-	-	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	-	-	-	-	-	-
CTR[5] Aquatic Life	-	-	-	0	0	0	-	0	0	0	-	-	-	-	-	-	-	0	0	0	-	-	0	0	0	0
NTR[6]	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC[7] Humans	-	-	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC[7] Aquatic Life	6[9]	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose[8]	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	0	-	0	-

Robinson Riffle Pond (A5L92821359)

	Aluminum		Arsenic		Cadmium		Chromium		Copper		Iron		Mercury	Methyl Mercury	Manganese		Nickel		Lead		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D	T	D	T	D
Maximum concentration	149	24	2.62	1.92	0.02	0.41	3.66	0.96	3.79	3.38	5290	968	0.0114	0.00057	2260	920	7.54	2.95	0.465	0.182	0.49	0.41	<0.203	<0.011	2.62	1.24
Minimum concentration	3	<1.5	0.28	0.21	<0.004	<0.004	<0.06	<0.07	0.10	<0.04	111	<2.08	0.0004	<0.00002	27.9	0.14	0.22	0.16	<0.01	<0.01	0.18	<0.11	<0.062	<0.001	0.15	<0.1
Number of samples	24	24	24	24	24	24	24	24	24	24	24	24	23	23	24	24	24	24	24	24	24	24	12	12	24	24
Number of samples exceeding criteria or objectives																										
Public Health Goal[1]	0	-	-	-	0	-	-	-	0	-	-	-	0	-	8	-	0	-	0	-	-	-	-	-	-	-
Primary MCL[2]	0	-	0	-	0	-	0	-	0	-	-	-	0	-	-	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL[2]	0	-	0	-	-	-	-	-	0	-	17	-	-	-	21	-	-	-	-	-	-	-	0	-	0	-
Agricultural Goal[3]	0	-	0	-	0	-	0	-	0	-	1	-	-	-	13	-	0	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor[4]	-	-	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR[5] Humans	-	-	-	-	-	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	-	-	-	-	-	-
CTR[5] Aquatic Life	-	-	-	0	0	0	-	0	0	0	-	-	-	-	-	-	-	0	0	0	-	-	0	0	0	0
NTR[6]	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC[7] Humans	-	-	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC[7] Aquatic Life	1[9]	-	-	-	-	-	-	-	-	-	9[9]	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose[8]	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	0	-	0	-

Appendix 6. Continued.

Upper Pacific Heights Pond (A5L92771367)

	Aluminum		Arsenic		Cadmium		Chromium		Copper		Iron		Mercury	Methyl Mercury	Manganese		Nickel		Lead		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D	T	D	T	D
Maximum detected	95	28	0.90	0.866	0.008	<0.13	1.90	0.47	1.27	0.98	182	50	0.0044	0.00019	19.9	7.38	1.04	0.87	0.10	0.093	0.27	0.170	<0.203	0.01	0.515	0.8
Minimum detected	5	<1.5	0.29	0.259	<0.002	<0.002	<0.07	<0.06	0.33	0.32	<2.93	<2.08	0.0003	<0.000025	1.08	0.05	0.050	<0.04	<0.01	<0.01	<0.04	<0.04	<0.006	<0.001	<0.035	<0.013
Number of samples	25	24	25	24	25	24	25	24	25	24	25	24	24	24	25	24	25	24	25	24	25	24	13	12	25	24
Number of samples exceeding criteria or																										
Public Health Goal[1]	0	-	-	-	0	-	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL[2]	0	-	0	-	0	-	0	-	0	-	-	-	0	-	-	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL[2]	0	-	0	-	-	-	-	-	0	-	0	-	-	-	0	-	-	-	-	-	-	-	0	-	0	-
Agricultural Goal[3]	0	-	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor[4]	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR[5] Humans	-	-	-	-	-	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	-	-	-	-	-	-
CTR[5] Aquatic Life	-	-	-	0	0	0	-	0	0	0	-	-	-	-	-	-	-	0	0	0	-	-	0	0	0	0
NTR[6]	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC[7] Humans	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC[7] Aquatic Life	1[9]	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose[8]	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	0	-	0	-

Feather R NR Mile Long Pond (A5-1662.50)

	Aluminum		Arsenic		Cadmium		Chromium		Copper		Iron		Mercury	Methyl Mercury	Manganese		Nickel		Lead		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D	T	D	T	D
Maximum detected	175	77.4	0.763	0.65	0.061	0.003	1.32	0.73	1.42	1.14	263	67.7	0.00225	0.000114	20.5	11.6	1.57	1.22	0.313	0.066	0.21	0.07	<0.273	0.04	0.87	0.57
Minimum detected	16.7	0.02	0.395	0.364	<0.004	<0.004	0.11	<0.02	0.65	0.51	20.7	<3.25	0.00029	0.000017	1.73	0.084	0.42	0.25	0.015	<0.003	<0.033	<0.089	<0.006	<0.006	<0.10	<0.023
Number of samples	29	29	29	29	29	29	29	29	29	29	29	29	29	28	29	29	29	29	29	29	29	29	14	14	29	29
Number of samples exceeding criteria or objectives																										
Public Health Goal[1]	0	-	-	-	0	-	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL[2]	0	-	0	-	0	-	0	-	0	-	-	-	0	-	-	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL[2]	0	-	0	-	-	-	-	-	0	-	0	-	-	-	0	-	-	-	-	-	-	-	0	-	0	-
Agricultural Goal[3]	0	-	0	-	0	-	0	-	0	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor[4]	-	-	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR[5] Humans	-	-	-	-	-	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	-	-	-	-	-	-
CTR[5] Aquatic Life	-	-	-	0	0	0	-	0	0	0	-	-	-	-	-	-	-	0	0	0	-	-	0	0	0	0
NTR[6]	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC[7] Humans	-	-	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC[7] Aquatic Life	6[9]	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose[8]	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	0	-	0	-

Appendix 6. Continued

Mile Long Pond Surface (A59L92541377)

	Aluminum		Arsenic		Cadmium		Chromium		Copper		Iron		Mercury	Methyl Mercury	Manganese		Nickel		Lead		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D	T	D	T	D
Maximum detected	48	6.1	0.776	0.757	<0.039	<0.039	1.46	0.310	1.07	0.640	329	156	0.00144	0.000089	216	70	0.74	1.41	0.162	0.118	0.372	<0.30	0.083	0.008	0.48	0.89
Minimum detected	<1.5	<1.5	0.081	0.065	<0.002	<0.002	<0.039	<0.039	0.04	<0.191	9.8	<2.08	0.00021	<0.000025	7.2	<0.06	<0.04	<0.04	<0.002	<0.001	<0.06	<0.04	<0.006	<0.001	<0.011	<0.013
Number of samples	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	12	12	24	24
Number of samples exceeding criteria or																										
Public Health Goal[1]	0	-	-	-	0	-	-	-	0	-	-	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-
Primary MCL[2]	0	-	0	-	0	-	0	-	0	-	-	-	0	-	-	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL[2]	0	-	0	-	-	-	-	-	0	-	1	-	-	-	4	-	-	-	-	-	-	-	0	-	0	-
Agricultural Goal[3]	0	-	0	-	0	-	0	-	0	-	0	-	-	-	1	-	0	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor[4]	-	-	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR[5] Humans	-	-	-	-	-	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	-	-	-	-	-	-
CTR[5] Aquatic Life	-	-	-	0	0	0	-	0	0	0	-	-	-	-	-	-	-	0	0	0	-	-	0	0	0	0
NTR[6]	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC[7] Humans	-	-	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC[7] Aquatic Life	0	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose[8]	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	0	-	0	-

Mile Long Pond Bottom (A59L92541377)

	Aluminum		Arsenic		Cadmium		Chromium		Copper		Iron		Mercury	Methyl Mercury	Manganese		Nickel		Lead		Selenium		Silver		Zinc	
	T	D	T	D	T	D	T	D	T	D	T	D	T	T	T	D	T	D	T	D	T	D	T	D	T	D
Maximum detected	5.0	1.7	0.569	0.391	<0.008	<0.008	0.10	0.10	173	3.4	337	81.3	0.00117	0.000187	882	36.9	0.41	0.33	0.027	0.004	0.080	0.080			0.69	0.48
Minimum detected	<1.5	0.4	0.328	0.330	<0.002	<0.004	<0.06	<0.06	1.27	0.33	79	11.3	0.00046	0.000068	14.7	4.92	0.13	0.08	<0.002	0.004	<0.20	<0.20			0.10	0.12
Number of samples	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	0	0	4	3
Number of samples exceeding criteria or																										
Public Health Goal[1]	0	-	-	-	0	-	-	-	1	-	-	-	0	-	1	-	0	-	0	-	-	-	-	-	-	-
Primary MCL[2]	0	-	0	-	0	-	0	-	0	-	-	-	0	-	-	-	0	-	0	-	0	-	-	-	-	-
Secondary MCL[2]	0	-	0	-	-	-	-	-	0	-	2	-	-	-	2	-	-	-	-	-	-	-	-	-	0	-
Agricultural Goal[3]	0	-	0	-	0	-	0	-	0	-	0	-	-	-	2	-	0	-	0	-	0	-	-	-	0	-
Cal/EPA Cancer Potency Factor[4]	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CTR[5] Humans	-	-	-	-	-	-	-	-	0	-	-	-	0	-	-	-	0	-	-	-	-	-	-	-	-	-
CTR[5] Aquatic Life	-	-	-	0	0	0	-	0	1[9], 1[10]	0	-	-	-	-	-	-	-	0	0	0	-	-	-	-	0	0
NTR[6]	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
NAWQC[7] Humans	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NAWQC[7] Aquatic Life	0	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-
USEPA IRIS Reference Dose[8]	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	-	0	-

Appendix 6. Continued

Footnotes:

1. California Environmental Protection Agency (Cal/EPA), Office of Environmental Health Hazard Assessment, *Public Health Goals for Chemicals in Drinking Water*
2. California Department of Health Services, California Code of Regulations, Title 22, Division 4, Chapter 15, Domestic Water Quality and Monitoring
3. Food and Agriculture Organization of the United Nations, 1985. Water Quality for Agriculture.
4. Cal/EPA, Office of Environmental Health Hazard Assessment, Cal/EPA Toxicity Criteria Database
5. California State Water Resources Control Board, Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (2 March 2003)
6. U.S. Environmental Protection Agency, Federal Register, Volume 64, No. 216 (Tuesday, 9 November 1999) [National Toxics Rule revisions]
7. U.S. Environmental Protection Agency, Quality Criteria for Water, 1986 (May 1986) [The Gold Book] plus updates (various dates)
8. U.S. Environmental Protection Agency, Integrated Risk Information System [IRIS] database
9. Chronic (4 day average)
10. Acute (1 hr average)

Appendix 7. Summary of nutrient numerical limits for the Feather River and the Oroville Wildlife area ponds (µg/L).

Feather R DS HWY 162 (A5-1740.50)

	Ammonia		Nitrate + Nitrite	Ortho-phosphate	Phosphorus	Organic Carbon	
	T	D	D	D	T	T	D
Maximum detected	0.2	0.05	0.2	0.02	0.10	12.0	2.2
Minimum detected	<0.02	<0.01	0.01	<0.01	<0.01	1.2	1.1
Number of samples	30	29	30	30	30	28	28
Number of samples exceeding criteria or objectives							
Tastes and Odors[1]	0	-	-	-	-	-	-
Primary MCL[2]	-	-	0	-	-	-	-
NAWQC[3] Aquatic Life	0	-	-	-	-	-	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	2	-	-
USEPA Draft Health Advisory[5]	0	-	-	-	-	-	-
California Public Health Goal[6]	-	-	0	-	-	-	-

Oroville Fishing Pond (A5L92951347)

	Ammonia		Nitrate + Nitrite	Ortho-phosphate	Phosphorus	Organic Carbon	
	T	D	D	D	T	T	D
Maximum detected	0.25	0.16	1.5	0.06	0.2	12.3	6.7
Minimum detected	<0.08	<0.01	<0.01	<0.01	0.02	3.0	2.4
Number of samples	24	24	24	24	24	23	23
Number of samples exceeding criteria or objectives							
Tastes and odors[1]	0	-	-	-	-	-	-
Primary MCL[2]	-	-	0	-	-	-	-
NAWQC[3] Aquatic Life	0	-	-	-	-	-	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	-	-	-
USEPA Draft Health Advisory[5]	0	-	-	-	-	-	-
California Public Health Goal[6]	-	-	0	-	-	-	-

Feather R A Robinson Riffle (A5-1712.50)

	Ammonia		Nitrate + Nitrite	Ortho-phosphate	Phosphorus	Organic Carbon	
	T	D	D	D	T	T	D
Maximum detected	0.2	0.09	0.39	0.06	0.08	3.1	2.5
Minimum detected	<0.02	<0.01	<0.01	<0.01	<0.01	1.2	1.1
Number of samples	30	29	30	30	30	27	28
Number of samples exceeding criteria or objectives							
Tastes and Odors[1]	0	-	-	-	-	-	-
Primary MCL[2]	-	-	0	-	-	-	-
NAWQC[3] Aquatic Life	0	-	-	-	-	-	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	4	-	-
USEPA Draft Health Advisory[5]	0	-	-	-	-	-	-
California Public Health Goal[6]	-	-	0	-	-	-	-

Appendix 7. Continued.

Robinson Riffle Pond (A5L92821359)

	Ammonia		Nitrate + Nitrite	Ortho-phosphate	Phosphorus	Organic Carbon	
	T	D	D	D	T	T	D
Maximum detected	0.2	0.04	0.12	0.01	0.51	39.8	6.7
Minimum detected	<0.08	<0.01	<0.01	<0.01	0.02	3.2	2.7
Number of samples	24	24	24	24	24	23	23
Number of samples exceeding criteria or objectives							
Tastes and odors [1]	0	-	-	-	-	-	-
Primary MCL[2]	-	-	0	-	-	-	-
NAWQC[3] Aquatic Life	0	-	-	-	-	-	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	-	-	-
USEPA Draft Health Advisory [5]	0	-	-	-	-	-	-
California Public Health Goal [6]	-	-	0	-	-	-	-

Upper Pacific Heights Pond (A5L92771367)

	Ammonia		Nitrate + Nitrite	Ortho-phosphate	Phosphorus	Organic Carbon	
	T	D	D	D	T	T	D
Maximum detected	0.13	0.1	0.09	<0.1	0.70	2.7	1.9
Minimum detected	<0.02	<0.01	<0.01	<0.01	<0.01	1.5	1.1
Number of samples	24	24	24	24	24	23	23
Number of samples exceeding criteria or objectives							
Tastes and odors [1]	-	-	-	-	-	-	-
Primary MCL[2]	-	-	0	-	-	-	-
NAWQC[3] Aquatic Life	0	-	-	-	-	-	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	-	-	-
USEPA Draft Health Advisory [5]	0	-	-	-	-	-	-
California Public Health Goal [6]	-	-	0	-	-	-	-

Feather R US from Afterbay Outlet (A5-1695.50)

	Ammonia		Nitrate + Nitrite	Ortho-phosphate	Phosphorus	Organic Carbon	
	T	D	D	D	T	T	D
Maximum detected	0.1	0.07	0.24	0.03	0.45	3.3	3.0
Minimum detected	<0.02	<0.01	<0.01	<0.01	<0.01	1.3	1.1
Number of samples	30	30	31	31	31	29	29
Number of samples exceeding criteria or objectives							
Tastes and Odors[1]	0	-	-	-	-	-	-
Primary MCL[2]	-	-	0	-	-	-	-
NAWQC[3] Aquatic Life	0	-	-	-	-	-	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	4	-	-
USEPA Draft Health Advisory [5]	0	-	-	-	-	-	-
California Public Health Goal [6]	-	-	0	-	-	-	-

Appendix 7. Continued.

Mile Long Pond Surface (A59L92541377)

	Ammonia		Nitrate + Nitrite	Ortho-phosphate	Phosphorus	Organic Carbon	
	T	D	D	D	T	T	D
Maximum detected	0.23	<0.2	0.19	0.02	0.20	3.8	3.0
Minimum detected	<0.02	<0.01	<0.01	<0.01	<0.01	2.0	1.3
Number of samples	23	24	24	24	24	23	23
Number of samples exceeding criteria or objectives							
Tastes and Odors[1]	0	-	-	-	-	-	-
Primary MCL[2]	-	-	0	-	-	-	-
NAWQC[3] Aquatic Life	0	-	-	-	-	-	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	-	-	-
USEPA Draft Health Advisory[5]	-	-	-	-	-	-	-
California Public Health Goal[6]	-	-	0	-	-	-	-

Mile Long Pond Bottom (A59L92541377)

	Ammonia		Nitrate + Nitrite	Ortho-phosphate	Phosphorus	Organic Carbon	
	T	D	D	D	T	T	D
Maximum detected	0.2	0.20	0.01	0.2	0.11	5.0	2.7
Minimum detected	<0.02	<0.01	<0.01	<0.01	0.01	2.0	1.3
Number of samples	23	24	24	24	23	23	23
Number of samples exceeding criteria or objectives							
Tastes and Odors[1]	0	-	-	-	-	-	-
Primary MCL[2]	-	-	0	-	-	-	-
NAWQC[3] Aquatic Life	0	-	-	-	-	-	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	-	-	-
USEPA Draft Health Advisory[5]	-	-	-	-	-	-	-
California Public Health Goal[6]	-	-	0	-	-	-	-

Feather R NR Mile Long Pond (A5-1662.50)

	Ammonia		Nitrate + Nitrite	Ortho-phosphate	Phosphorus	Organic Carbon	
	T	D	D	D	T	T	D
Maximum detected	0.1	0.04	0.2	0.14	0.11	2.5	2.8
Minimum detected	<0.02	<0.01	<0.01	<0.01	<0.01	1.2	0.8
Number of samples	30	29	30	30	30	28	28
Number of samples exceeding criteria or objectives							
Tastes and Odors[1]	0	-	-	-	-	-	-
Primary MCL[2]	-	-	0	-	-	-	-
NAWQC[3] Aquatic Life	0	-	-	-	-	-	-
USEPA Recommended Ecoregional Nutrient Criteria[4]	-	-	-	-	2	-	-
USEPA Draft Health Advisory[5]	0	-	-	-	-	-	-
California Public Health Goal[6]	-	-	0	-	-	-	-

Appendix 7. Continued.

Footnotes

1. J.E. Amoore and E. Hautala. Odor as an aid to chemical safety: Odor thresholds compared with threshold limit values and volatilities for 214 industrial chemicals in air and water dilution. Journal of Applied Toxicology, 3(6):272-290. 1983
2. California Department of Health Services, California Code of Regulations, Title 22, Division 4, Chapter 15, Domestic Water Quality and Monitoring
3. U.S. Environmental Protection Agency, Quality Criteria for Water, 1986 (May 1986) [The Gold Book] plus updates (various dates)
4. U.S. Environmental Protection Agency, Ambient Water Quality Criteria Recommendations for both Rivers and Streams in Ecoregion 1. 2001. EPA 822-B-01-012
5. U.S. Environmental Protection Agency, Office of Water, 2004 Edition of the Drinking Water Standards and Health Advisories. (Winter 2004). EPA 822-R-04-005.
6. California Environmental Protection Agency (Cal/EPA), Office of Environmental Health Hazard Assessment, Public Health Goals for Chemicals in Drinking Water (various dates), http://www.oehha.org/water.phg/.
7. Chronic (4 day average)
8. Acute (1 hr average)